SCIENCE ABSTRACTS

SECTION A

PHYSICS.

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VOL. 34 | SEPTEMBER 1931 (Abstracts 2899–3283) | No. 405

EDITED AND ISSUED MONTHLY BY
THE INSTITUTION OF ELECTRICAL ENGINEERS
Savoy Place, Victoria Embankment, London, W.C.2.
IN ASSOCIATION WITH
THE PHYSICAL SOCIETY OF LONDON,
THE AMERICAN PHYSICAL SOCIETY,
THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND
L'ASSOCIAZIONE ELETTROTECNICA ITALIANA.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER, 1931.

GENERAL PHYSICS.

2899. Pirani Gauge for the Measurement of Small Changes of Pressure. A. Ellett and R. M. Zabel. *Phys. Rev.* 37. *pp.* 1102–1111, *May* 1, 1931.—The application of the Pirani gauge to the measurement of small pressure changes is discussed. Both nickel and tungsten wires are used as filaments in the gauge. Nickel wire not only has the greater sensitivity, but possesses several other advantages. The theory of the gauge is developed so that it is possible to predict the effect of change in length or diameter of the wire upon the sensitivity of the gauge. The theory also predicts that there is an optimum temperature to which the wire should be heated for maximum sensitivity of the gauge. The observed and computed values of the optimum temperature are compared. In some cases the agreement is as good as can be expected, and in the others the discrepancy is easily explained. The maximum sensitivity attained is a galvanometer deflection of 1 mm. for a pressure change of air equivalent to 5×10^{-9} mm. of mercury. AUTHORS.

2900. Automatic Race Timer. E. A. Speakman. *Rev. Sci. Instruments*, 2. *pp.* 297–304, *May*, 1931.—The instrument described is used to time races by the use of a microphone, a photoelectric cell, an amplifier and a clock. The time is recorded in 1/120th of a second from the instant when the sound of the starting gun reaches the runner's ear to the instant when the runner's chest touches the tape at the finish.

AUTHOR.

2901. Pore Dimensions of Ultra-Filters. H. Bechhold, M. Schlesinger and K. Silbereisen. *Kolloid Zeits.* 55. *pp.* 172–198, *May*, 1931.—An apparatus is described which permits pore dimensional measurements with liquid-liquid systems. The preliminary treatment of ultra-filters is discussed and its effect on pore dimensions investigated. The influence of experimental conditions on the data obtained, *e.g.*, duration and amount of pressure, possible errors, etc., is examined at length for various types of filter. A special section is devoted to the underlying theory with special reference to liquid friction. An Appendix gives dimensional data for several varieties of ultra-filter, including glacial acetic acid-collodion ultra-filters of easily reproducible permeability.

H. H. Ho.

2902. Portable Instrument for Rapid Measurement of Gravity. F. Holweck and P. Lejay. *Comptes Rendus*, 192. *pp.* 1116–1119, *May* 4, 1931.—As a result of experience modifications have been introduced in

this instrument, which is now figured. In particular, chronometers are replaced by an auxiliary free pendulum and vibrations are recorded by a stroboscopic arrangement, with the result that the accuracy is increased tenfold. Tested at Lyons, the results agreed with those of the Swiss Geodetical Commission, and identical values were obtained before and after the instrument had travelled 2000 km. by motor. [See also Abstract 3609 (1930).] C. A. S.

2903. Method of Making Wetting Visible. W. Haller. *Kolloid Zeits.* 55. *pp.* 1–3, *April,* 1931.—A special optical arrangement is described which permits wetting in glass tubes to be made clearly visible. The method also permits the demonstration of very thin and otherwise invisible wetting films. J. K.

2904. Capillarity. Capillary Rise in Disperse Systems. K. Schultze. *Kolloid Zeits.* 55. *pp.* 9–25, *April,* 1931.—Reference is made to an earlier work on salt-containing gels [see Abstract 3613 (1930)]. It appears to the author as a result of theoretical considerations and measurements of the capillary rise and height of the meniscus from the point of view of the capillary radius of curvature that we have really a double capillary phenomenon, namely, the rise in open capillary walls and the rise between the liquid capillary walls thus built. The introduction of a special " wetting-tension " appears unnecessary. J. K.

2905. Calculation of Surface Tension from the Rise of Liquids in Capillary Tubes. A. W. Porter. *Faraday Soc., Trans.* 27. *pp.* 205–210, *May,* 1931.—By taking as the independent variable, not r/h but $r(h + r/3)$, in Rayleigh's extended form of Poisson's equation for the case in which the contact angle is zero, a rapidly convergent series is obtained which yields more satisfactory values than does Rayleigh's approximate equation. For contact angles other than zero, an equation is derived for finding β^2, and graphical methods of solution are described. H. F. G.

2906. Boundary-Angle Measurement and its Importance in Technical Processes. O. Herstad. *Kolloid Zeits.* 55. *pp.* 169–171, *May,* 1931.—The accurate treatment of the boundary angle at the solid-liquid interface is not easy, owing to the effects of any impurities, especially on the solid surface. The present paper contains a full account of a suitable apparatus for the purpose and interesting applications are described, *e.g.*, the correctness of Quincke's opinion that in many cases the angle of contact is zero, especially for wetting liquids; also that for equally cleaned surfaces the change of contact angle is caused by the different capacities for electrical charging of the solid surfaces. H. H. Ho.

2907. Viscous Friction. P. Mercier. *J. de Physique et le Radium,* 2. *pp.* 114–132, *April,* 1931.—Regarding a viscous liquid in motion as made up of films of molecular thickness gliding over one another with velocities varying linearly with the distance from the boundary, Poiseuille's formula is deduced, and also a relation between the viscous friction, μ, and the couple produced on a cylinder placed concentrically within another (movable) cylinder, the space between being filled with the liquid under examination, and the outer cylinder rapidly rotated. Preliminary results with olive oil and a mineral oil show μ to be independent of the velocity of rotation up to 4000 r.p.m. C. A. S.

2908. Viscosity Paradox. E. N. da C. Andrade. *Faraday Soc., Trans.* 27. *pp.* 201–203, *May*, 1931.—The equation for the axial flow of a viscous liquid in the space between two concentric cylinders yields a zero value of the rate of flow when the radius r_0 of the inner cylinder becomes zero, but it is nevertheless consistent with the ordinary equation for the rate through a single tube in which the rate is a maximum at $r = 0$. By calculation of the position of the maximum rate for different values of the ratio between the two radii, it is shown that in the limit, *i.e.*, when $r_0 = 0$, the velocity-distribution curve becomes parabolic, but that with finite, although small, values of r_0 the total flow is reduced considerably and the maximum is displaced. Thus, introduction of an axial wire of radius 0·0001 that of the tube reduces the flow by more than 10 %.

H. F. G.

2909. Distribution of Velocities in Colloidal Solutions with Viscosity Anomalies. M. Pichot and P. Dupin. *Comptes Rendus*, 192. *pp.* 1079–1081, *May* 4, 1931.—The flow of certain colloidal solutions, *e.g.*, gelatin, ammonium oleate, benzopurpurin, etc., through a capillary tube, does not obey Poiseuille's law, and the anomaly has been attributed to a variation of the coefficient of viscosity with charge. The present paper relates to experimental work, using Camichel's chronophotographic method, on the distribution of velocity between two parallel planes for a 0·7 % solution of gelatin. The experiments have eliminated, for the case of gelatin, all empirical formulæ and theories of phenomena leading to a law of progressively decreasing velocity from the median plane to the wall, whilst the distribution of velocities conforms to the theories of Buckingham and Bingham.

H. H. Ho.

2910. Motion of a Rectilinear Vortex. A. Masotti. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 235–245, *March* 15, 1931.—Studies the motion of a rectilinear vortex in presence of a plane wall to which it is parallel. The motion is plane. Let G_{MM} be the value assumed at the pole M by Green's first function, relative to the plane field occupied by the liquid and having a pole M. Then the current-function of the motion of the vortex is given by $\psi^2 = -(C/4\pi)G_{MM}$, where C is the intensity of the vortex. The trajectories of the vortex motion are then the level lines of the function G_{MM}. Comparison is made with the methods and results of Routh, Caldonazzo and Vilari.

A. D.

2911. Oberbeck's Vortices. S. K. Banerji and R. V. Barave. *Phil. Mag.* 11. *pp.* 1057–1081, *May*, 1931.—The detailed structure of the liquid vortices produced by Oberbeck's experiments has been studied. An automatic arrangement has been devised so that the same vortex may be reproduced any number of times. The stream lines in the moving liquid were traced by colouring its specific parts, and these were photographed at various stages of the motion. The space-time relationship was obtained by kinematographic films with an arrangement for recording time. A longitudinal section of the moving liquid shows that the stream lines have the form of a double spiral advancing through the liquid and at the same time presenting an increased number of convolutions, and followed by a "tail." The "tail" contracts and after a time the spirals close up, and the moving liquid is transformed to an anchor-shaped vortex before its final dissipation. There appear to be three distinct stages in the life history of the vortex, *viz.*, (1) when under the influence of the tube,

(2) free development uninfluenced by the boundary, and (3) transformation into an anchor-shaped vortex which meets with dissolution. Each stage is associated with a distinct change in the structure and rotational motion of the vortex which has been studied in detail in this paper and is accompanied by relevant mathematical theory. H. H. Ho.

2912. Flow of Water through a Circular Tube with a Central Core and through Rectangular Tubes. F. C. Lea and A. G. Tadros. *Phil. Mag.* 11. *pp.* 1235–1247, *May*, 1931.—The tests indicate that when a small core is placed at the centre of a circular tube, the discharge at velocities corresponding to small Reynolds numbers is much greater than theory gives on the assumption of no slip at the boundary. Small turbulent disturbances, which originally existed in the flowing water, and would be destroyed in a circular or rectangular tube without a core up to velocities corresponding to a Reynolds number of 2000, persist at velocities much lower than in the circular or rectangular tube. These small disturbances have the same effect as though slip were taking place at the inner core. When the radius of the core is equal to half the radius of the tube, the theoretical and experimental values agree. If v is the mean velocity of flow, the apparent velocity of slip at the boundary is given by $v = 2{\cdot}82\sqrt{0{\cdot}5 - \frac{a_0}{a_1}}$, where a_0 is the radius of the core and a_1 of the tube. In an Appendix, formulæ are deduced for rectangular tubes and stream-line flow. H. H. Ho.

2913. Wave Resistance of a Spheroid. T. H. Havelock. *Roy. Soc., Proc.* 131. *pp.* 275–285, *May* 1, 1931.—A method which has been used to calculate the wave resistance of a submerged solid is to replace the solid by a distribution of sources and sinks, or of doublets, the distribution being the image system for the solid in a uniform stream. The cases hitherto considered have been limited to those in which the image system is either a single doublet or a distribution of doublets lying in a vertical plane parallel to the direction of motion. It is now shown how to obtain the solution for an ellipsoid moving horizontally at a given depth below the surface of the water, and with its axes in any assigned direction, the special cases dealt with being prolate and oblate spheroids moving end-on and broadside-on. H. H. Ho.

2914. Cavitations of Permanent Form. H. Poncin. *Comptes Rendus*, 192. *pp.* 1197–1198, *May* 18, 1931.—Motion of an incompressible fluid, contained in a vertical cylinder, in which cavitations can exist without change of form is briefly discussed. J. S. G. T.

2915. Operation of the Pitot Tube and Impact of a Turbulent Jet on a Plate. L. Escande and Teissié-Solier. *Comptes Rendus*, 192. *pp.* 1152–1154, *May* 11, *and pp.* 1306–1309, *May* 26, 1931.—(1) The variation of the constant k in the expression for the velocity of flow, as determined by the Pitot tube, with the position of the orifice, has been investigated. At two positions k is unity, and for the intermediate position at which the sensitivity is a maximum, its value is 0·78. With increase of the distance of the orifice from the up-stream end of the tube, the function $1 - (H_1 - H_2)/(V^2/2g)$, where V is the velocity of flow, at first falls from unity to a negative value and then rises slowly to zero. (2) For both turbulent and quiet flow, k, under specified conditions, is constant and equal to unity, and is independent of the dimensions of the

surface surrounding the up-stream end of the tube. The calculated and observed values of the impact of a turbulent jet are in close agreement, and the Dubuat paradox is not applicable. H. F. G.

2916. Aerodynamics. L. Poggi. *Pont. Accad. Sci., N. Lincei, Atti,* 84. *pp.* 246–257, *March* 15, 1931.—The field of velocity determined by the action on an elliptical cylinder by a translatory current and by a vortex whose axis is parallel to that of the elliptical cylinder. Deduction of the diagram of charge upon the major axis of the ellipse, per unit of length of the ellipse. Then the global actions on the unit length of the cylinder are determined. Some numerical results are worked out. A. D.

2917. Velocity of Propagation of Diffusion. K. Sitte. *Phys. Zeits.* 32. *pp.* 410–414, *May* 15, 1931.—Verifies experimentally the formula of P. Frank for the distance ξ in a direction x, reached by the foremost molecule of a diffusing substance which started at $x = 0$ at the zero of time, *viz.*, $\xi = 2f(\mathrm{N})\sqrt{\mathrm{D} \cdot t}$. D is the coefficient of diffusion. The observations are made microscopically on a colloidal solution of gold, prepared by Zsigmondy's method, and by a special manner of combining the results of a single experiment, the variations of ξ with both N (the number of diffusing particles) and the time t are simultaneously obtained. A complete verification of Frank's formula results. J. P. A.

2918. Solidity of Rock-Salt in Water. U. Heine. *Zeits. f. Physik,* 68. 9–10. *pp.* 591–609, *April* 13, 1931.—Investigates with greater accuracy than previously the relation between the high values for the strength in tension of rock-salt when surrounded with water and the other experimental parameters, and the influence of the original properties of the crystals. The author applied small loads to the crystals tested (72 gm.), so that the original tension lay below the dry elastic limit of the substance. The stretching was perpendicular to cube planes of the crystal, which was surrounded with distilled water and was pulled upwards, so that when it dissolved away and broke, the upper portion was at once removed from the water and the area of the section could be measured after it had been dried with alcohol. At the same time the plastic elongation of the crystal was measured, it increased with the final strength of the material. The final strengths observed agreed in order of magnitude with the increased strengths of dry crystals heated to high temperatures, and were very much greater than the strengths of dry crystals at ordinary temperatures. H. N. A.

2919. Experiments on Cohesion. Part II. Effect of Pressure and Percussion on Rock-Salt. H. Tertsch. *Zeits. f. Krist.* 78. 1–2. *pp.* 53–75, *May,* 1931.—Using the same apparatus [see Abstract 17 (1931)], the energy, applied by the knife-edge as pressure, required to rupture a completely supported slab of rock-salt is related linearly to the thickness of the slab; if applied as a blow, the relation is parabolic, and much less energy is required. In both cases there is considerable variation, and the results are very sensitive to the orientation of the slab relatively to its cleavage plane. No relation was traceable to the distance from the edge at which the pressure or blow was applied, but slabs placed on edge required substantially less energy to split them. C. A. S.

2920. Empirical Law of Atomic Repulsion in Relation to the Cohesion Properties of Solids. G. A. Tomlinson. *Phil. Mag.* 11. *pp.* 1009–1052, *May,* 1931.—The author considers the term dealing with

the repulsive forces in the crystal lattice. The usual Born expression for the potential energy of a unit cube leads to a repulsive force varying inversely as a high power of the inter-atomic distance. Another method is now proposed by starting with the "experimental" equation for the compressibilities of the alkali halides, *i.e.*, $K = K_0(1 - \lambda P)$, in which K_0 is the compressibility when P the pressure is zero, λ being a constant. Calculation shows that the repulsion R can, on this assumption, be expressed as a power series in z, where z is the amount by which the inter-atomic distance is diminished by compression. Finally, $R = Le^{pz}$, where L and p are characteristic constants. The exponential nature of this equation is illuminating; it suggests that the force is a kind of quasi-elastic resistance; again, for the series of salts considered, it is independent of the nature of the atom. In general agreement with the results of Born and Landé, the repulsion potential energy is about $\frac{1}{9}$ the energy of attraction. An extension of this discussion to the equations of state for solids proposed by Sutherland and by Grüneisen concludes Part I. Part II assumes the general acceptance of the laws already deduced and applies them to the following elastic and thermal properties: elasticity, tenacity, atomic vibration frequency, thermal expansion. It is stressed throughout that the results are the outcome of empirical observations upon the compressibility, and thus the theory does not claim to be unique.

F. I. G. R.

2921. Determination of Principal Stresses from Crossed Nicol Observations. R. V. Baud. *Frank. Inst., J.* 211. *pp.* 457–474, *April*, 1931.—If p, q are two principal stresses in a transparent material, $p - q$ may be obtained from observations with crossed Nicols. Separation of p from q involves integration of the equations of equilibrium. The author shows how this integration may be performed in cases where polar, curvilinear orthogonal, and rectangular coordinates are employed. J. P. A.

2922. Variantive Theory for Finite Deformations. Yvonne Dupont. *Comptes Rendus*, 192. *pp.* 873–875, *April* 13, 1931.—In 1896 L. and E. Cosserat introduced a theory of finite deformations, which was extended by L. Brillouin in a paper on the theory of elasticity treated tensorially [see Abstract 2419 (1925)]. The author has extended this previous work, showing how Brillouin's tensors of deformation may be made doubly covariant. A. D.

2923. Vibrations of a Heavy Body Resting on an Elastic Layer. A. Steinbach. *Zeits. f. techn. Physik*, 12. 6. *pp.* 289–292, 1931.—A symmetrical, rigid mass rests on a uniform, massless layer of elastic material. The frequencies of the six possible modes of vibration are found in terms of the thickness of the layer, its elastic constants and the mass of the body. Changes in these frequencies produced by varying the elastic constants, the height of the centre of gravity above the layer and the disposition of the parts of the mass are discussed, and the results are recorded graphically. Certain ranges of frequency are avoided by four of the modes; resonance may therefore be obviated within these ranges.

J. P. A.

2924. Temperature Variation of Tensile Strength of Glass Rods. K. H. H. Müller. *Zeits. f. Physik*, 69. 7–8. *pp.* 431–455, *May* 28, 1931.—Thin glass rods of cross-sectional area q are broken at various temperatures under longitudinal tension L. The broken section exhibits

a reflecting patch, or " mirror," of area s, and a striated remainder. Reasons are given for believing that the " mirror " is formed comparatively slowly before the true break occurs, and that the tensile strength should be measured not by $Z = L/q$, but by $Z_0 = L/(q - s)$. A graph of Z against s/q is shown to be linear for smaller values of s/q, in accordance with this belief. Z_o is then a characteristic property of the material. For values of s/q approaching unity, Z decreases less rapidly and attains a lowest value Z_u when the " mirror " occupies the whole section. Z_u is the tensile strength most valuable in practice. Z_o generally decreases with increase of temperature, the temperature coefficient showing a qualitative connection with the temperature coefficient of Young's modulus for the same glass. The author's results are shown to agree with those of Winkelmann and Schott on similar glasses. Calculation of Z from chemical composition, after Gehlhoff and Thomas [see Abstract 1187 (1926)], cannot safely be performed. J. P. A.

2925. Temperature Coefficient of Young's Modulus for Glass. A. K. G. Schulze. *Zeits. f. Physik*, 69. 7–8. *pp.* 456–457, *May* 28, 1931.—By measuring the deflections of loaded beams, values of Young's modulus E are found for five standard glasses, at 20° C., 100° C. and 200° C., and the temperature coefficients deduced. For different specimens of the same glass, values of E vary considerably, but the temperature coefficients are more nearly constant. Annealing has the effect of raising the value of E and lowering the temperature coefficient. J. P. A.

2926. Invariants of Relative Motions. J. le Roux. *Comptes Rendus*, 192. *pp.* 871–873, *April* 13, 1931.—The movement of a system of material points may present different aspects according to the system of reference and to the time. It is interesting to investigate the intrinsic properties, those which persist whatever be the system of reference or the time. A geometrical point has no invariant, a material point has one, the mass. To find other invariants we must consider a system of n material points. The movement will be defined by the variation of the coordinates in terms of a parameter θ. On changing the system of reference, we transform the coordinates; and the parameters of this transformation are functions of θ. To each point of the system correspond six variables, x, y, z, x', y' and z'. The infinitesimal transformations of a function U, depending on the $6n$ variables of the system, are twelve in number, and belong to the four types

$$\Sigma\frac{\partial U}{\partial x},\quad \Sigma\left(y\frac{\partial U}{\partial z}-z\frac{\partial U}{\partial y}+y'\frac{\partial U}{\partial z'}-z'\frac{\partial U}{\partial y'}\right),\quad \Sigma\frac{\partial U}{\partial x'},\quad \text{and}\quad \Sigma\left(y\frac{\partial U}{\partial z'}-z\frac{\partial U}{\partial y'}\right).$$

If these infinitesimal transformations be applied to the kinetic energy $\frac{1}{2}\Sigma m(x^2 + y^2 + z^2)$, the first two give zero, the third gives the translation-resultant, and the fourth gives the resultant moment of the quantities of motion. Invariance of U is expressed by reducing to zero the above infinitesimal transformations. Systems of partial equations are thus reached which result in $(6n - 12)$ particular solutions independent of one another; and the most general invariant is an arbitrary function of these solutions. The invariants define the movement of the system. Conversely, the configuration shows the invariants. We may formulate the proposition that in order that two movements of a given system may be deduced the one from the other by the transformations above, with subse-

quent adjustment of the time, it is necessary and sufficient that they correspond so as to give the same succession of configurations. A. D.

2927. Dissipative Dynamical Systems. Part I. P. S. Bauer. *Nat. Acad. Sci., Proc.* 17. *pp.* 311–314, *May*, 1931.—Dynamical systems whose configuration is given in terms of a system of linear differential equations of the second order are defined analytically, and the following facts concerning the existence of algebraic variational principles for dissipative dynamical systems are established: (1) The equations of motion of either a conservative or a dissipative linear dynamical system are given by a variational principle if, and only if, (*a*) the masses of the system are constant, and (*b*) the dissipative coefficients are identically equal to the rates of change of the corresponding masses respectively. (2) The equations of motion of a dissipative linear dynamical system with constant coefficients are not given by a variational principle. J. S. G. T.

2928. Crystal Structure of Methane. H. H. Mooy. *K. Akad. Amsterdam, Proc.* 34. 4. *pp.* 550–553, 1931. *Comm. No.* 213*d from the Phys. Lab., Leiden.*—The observed spacings are compatible with those of a face-centred cubic translation lattice; side of the elementary cube $a = 5{\cdot}89 \pm 0{\cdot}01$Å.; with four molecules in this cube the calculated density is $0{\cdot}517 \pm 0{\cdot}006$, which is in good agreement with the Heuse value of $0{\cdot}522 \pm 0{\cdot}001$, and differs considerably from that deduced by the X-ray method by McLennan and Plummer, which was 0·413. The observed intensities differ slightly from those to be expected from a cubic close-packed structure of atoms, so that the molecular structure of CH_4 must be considered. H. N. A.

2929. Crystal Structure of Nitrates. C. Schaefer. *Zeits. f. Physik*, 68. 11–12. *pp.* 766–767, *April* 20, 1931.—Earlier observations on reflection of polarised infra-red radiation by the author and Schubert gave results for the carbonates and for sodium nitrate which were not analogous, in that two reflection maxima were given by the ordinary ray for carbonates, and one by the extraordinary ray, while in sodium nitrate all three maxima were given by both rays. In consequence a different structure has been attributed to the carbonates and the nitrates [see Abstract 816 (1928)]. Measurements have now been made on a new crystal, and it is found that unpolarised infra-red radiation reflected at a surface cut normal to the optic axis does not show the maximum at $12{\cdot}5\ \mu$. Consequently there is no evidence that the structure of sodium nitrate is any different from that of the carbonates. A. C. M.

2930. Crystal Structure of Anhydrous Sodium Sulphite. W. H. Zachariasen and H. E. Buckley. *Phys. Rev.* 37. *pp.* 1295–1305, *May* 15, 1931.—The hexagonal unit cell contains two molecules, and has the dimensions $a = 5{\cdot}441$ Å. and $c = 6{\cdot}133$ Å. The crystals are assumed to be twins with c as twinning axis. The SO_3 group is a low pyramid, like $(ClO_3)^-$, etc. F. I. G. R.

2931. Crystal Structure of Potassium Permanganate. R. C. L. Mooney. *Phys. Rev.* 37. *pp.* 1306–1310, *May* 15, 1931.—The unit cell is orthorhombic, with the following dimensions, $a = 9{\cdot}09$ Å., $b = 5{\cdot}72$ Å., $c = 7{\cdot}41$ Å., containing four molecules in the unit cell. The symmetry of the crystal is $2Di - 16(V_h^{16})$, and the atomic environment, nearly a regular tetrahedron. F. I. G. R.

2932. Geometrical Relations in Allotropy. H. Shôji. *Zeits. f. Krist.* 77. 5–6. *pp.* 381–410, *May*, 1931.—A discussion of the structural changes in the two or more crystalline modifications of a number of elements and compounds whose structure has already been determined by X-ray methods. W. H. Ge.

2933. Crystal Structure of Carbon Oxysulphide. L. Vegard. *Zeits. f. Krist.* 77. 5–6. *pp.* 411–423, *May*, 1931.—The material was solidified at liquid-air temperature and its density (1·52) determined in a special apparatus. From powder photographs taken with CuKα radiation, it was deduced that the unit trigonal cell, $a = 4{\cdot}08$ Å., $\omega = 98° 58'$, contains one molecule; space group C_3^4 or C_{3v}^5. The calculated intensities for the proposed structure agree well with those observed. W. H. Ge.

2934. Crystal Structure of Glycine. J. Hengstenberg and F. V. Lenel. *Zeits. f. Krist.* 77. 5–6. *pp.* 424–436, *May*, 1931.—From rotation and Weissenberg photographs it was deduced that the monoclinic unit cell of glycine containing four molecules of $NH_2 . CH_2 . COOH$ has dimensions $a = 5{\cdot}1$, $b = 11{\cdot}9$ and $c = 5{\cdot}43$ Å., $\beta = 111° 38'$, specific gravity 1·61, space group C_{2h}^5. The structure was deduced from absolute intensity measurements made on the ionisation spectrometer. W. H. Ge.

2935. Crystal Structure of Ammonium Chromate. Part I. D. J. Bujor. *Zeits. f. Krist.* 78. 1–2. *pp.* 1–15, *May*, 1931.—Ammonium chromate is monoclinic prismatic. The unit cell contains two molecules, and the space group appears to be C_s'. A detailed discussion of the atomic arrangement is reserved for a later paper. F. I. G. R.

2936. Crystal Structure of Beryllium Sulphate-Tetrahydrate. P. Schonefeld. *Zeits. f. Krist.* 78. 1–2. *pp.* 16–41, *May*, 1931.—$BeSO_4 . 4H_2O$ is tetragonal holohedral, containing four molecules to the unit cell, with the parameters $a = 8{\cdot}02 \pm 0{\cdot}020$ Å. and $c = 10{\cdot}75 \pm 0{\cdot}01$ Å. The space group is D_{4h}^{18}, and the lattice is ionic. F. I. G. R.

2937. X-Ray Investigation of Cyclohexane Derivatives. A. L. Patterson and T. N. White. *Zeits. f. Krist.* 78. 1–2. *pp.* 76–100, *May*, 1931. *In English.*—Previous investigations are discussed and a table is given of all possible isomeric and known cyclohexanols. Quebrachitol, 125/346- or 124/356-cyclohexanol, is monoclinic sphenoidal. Its unit cell has *a* 6·60, *b* 7·15, *c* 8·65 Å., $\beta = 90°$; space group (probably) C_2^2 (C_2p2). The following data are given:

Substance.	Crystal Class.	Unit Cell. Dimensions. *a*	*b*	*c*	β	Number of Molecules.	Density.	Space Group (probable).
l-Inositol.....	monoclinic sphenoidal	6·17	9·11	6·83	106·6°	2	1·598	$C_2^2(C_2p2)$
i-Inositol.....	monoclinic prismatic	6·64	12·0	19·7	105·8°	8	1·61	$C_{2h}^5(C_{2h}p..2)$
i-Inositol dihydrate	monoclinic prismatic	8·98	16·59	6·49	109·8°	4	1·58	$C_{2h}^5(C_{2h}p..2)$
Quercitol.....	monoclinic sphenoidal	6·83	8·53	6·45	110° 57′	2	1·5806	$2^2(C_2p2)$

Distances between atoms, *e.g.*, of carbon, are much greater in different molecules, but in the same molecule are much less than would be inferred from inorganic data, thus pointing to such molecules being tightly bound structures, although forming comparatively open crystal structures. C. A. S.

2938. Space Groups of Carbohydrates. J. Young and F. W. Spiers. *Zeits. f. Krist.* 78. 1–2. *pp.* 101–110, *May*, 1931. *In English.*—The following data have been determined by the rotation method with single crystals:

Substance.	Crystal System.	Unit Cell.					Density.	Space Group.
		a	*b*	*c*	β	Number of Molecules.		
γ-*d*-Mannonolactone	orthorhombic	14·0	11·1	4·73	—	4	1·61	V^4
2:3:5:6-tetramethyl-γ-*d*-mannonolactone	monoclinic	9·79	13·8	4·50	93·3°	2	1·26	C_2^2
2:3:5-trimethyl-γ-*l*-rhamnonolactone	orthorhombic	12·2	18·3	4·65	—	4	1·27	V^1
2:3:4-trimethyl-δ-*l*-arabonolactone	orthorhombic	10·8	12·2	7·30	—	4	1·30	V^4
2:3:4-trimethyl-α-*d*-xylopyranose	monoclinic	8·68	8·31	6·65	91°	2	1·30	C_2^2
1:3:4:5-tetramethyl-β-*d*-fructopyranose	orthorhombic	9·22	8·97	14·8	—	4	1·30	V^4
1:3:4:5-tetraacetyl-β-*d*-fructopyranose	monoclinic	10·7	7·98	17·0	144·5°	2	1·36	C_2^1

C. A. S.

2939. Crystal Structure of Eulytine. G. Menzer. *Zeits. f. Krist.* 78. 1–2. *pp.* 136–163, *May*, 1931.—The compound is face-centred cubic, with edge $= 10{\cdot}272 \pm 0{\cdot}004°$ Å. The unit cell contains four molecules. Space group T_d^6. F. I. G. R.

2940. X-Ray Investigations of the System Sulphur-Selenium. Part III. The Space Lattice of Mixed Crystals of Groth's Type A. F. Halla, E. Mehl and F. X. Bosch. *Zeits. f. phys. Chem.* 12. *Abt. B.* 5. *pp.* 377–386, *May*, 1931.—The crystals under examination contained 33·4 atomic % Se. Space group C_{2h}^2 (simple monoclinic translation lattice). The elementary cell contains 32 atoms, and has the following parameters: $a' = 8{\cdot}48$ Å., $b' = 13{\cdot}34$ Å., $c' = 8{\cdot}33$ Å., $\beta' = 67° 30'$. Piezoelectric effect negative. [See Abstract 2166 (1931).] F. I. G. R.

2941. Determination of Size and Shape of Sub-Microscopic Crystals by Means of X-Rays. R. Brill. *Kolloid Zeits.* 55. *pp.* 164–169, *May*, 1931.—Interference methods are described, accompanied by the relevant theory, for obtaining the coarse structure (in contrast to the fine lattice structure) of matter. H. H. Ho.

2942. Graphical Methods for the Determination of Quadratic Forms from X-Ray Powder Diagrams. T. Bjurström. *Zeits. f. Physik*, 69. 5–6. *pp.* 346–355, *May* 12, 1931.—All interferences can be used. Applications are given for rhombic lattices. F. I. G. R.

2943. Causes of Line-Broadening in X-Ray Powder and Rotation Photographs. U. Dehlinger. *Zeits. f. Metallkunde*, 23. *pp.* 147–149, *May*, 1931.—Considers three reasons for the effect, mainly with

particular reference to polycrystalline aggregates. They are (1) slow oscillations in the lattice, (2) abnormally small size of grain and (3) rapid oscillations in the lattice. The various cases are depicted graphically. The following experimental results are brought forward: (*a*) the broadening occurs for Cu, Ag, Fe, W, in rolling and drawing, but not to any appreciable extent in free drawing; (*b*) the phenomenon does not arise for Al and Zn, from which it is inferred that no connection between strength and line-broadening exists, since the cases quoted do not differ essentially from each other. The paper concludes with the discussion of a number of other factors concerned with tension. F. I. G. R.

2944. Combination Banding and Grooving in Crystals. G. Kalb. *Zeits. f. Krist.* 78. 1–2. *pp.* 42–52, *May*, 1931.—Combination banding denotes the oscillational combination of surfaces with simple rational indices. Combination grooving means the oscillational combination of vicinal faces. The phenomena are illustrated by examples. F. I. G. R.

2945. New Photographic Method for Crystal Research. A. Schubnikow. *Zeits. f. Krist.* 78. 1–2. *pp.* 111–135, *May*, 1931.—An arrangement amplifying Rösch's method. The crystal under examination is clamped within a flask containing fluid of which the refractive index differs little from that of the crystal. A simple optical path and plate-holder complete the apparatus. It is claimed that good results can be obtained for the study of crystal form, etch-figures, and a number of purposes in crystal chemistry. Illustrations show photographs obtained of tourmaline, topaz, phenacite, mica, potassium iodide and chrome alum in various immersion media. F. I. G. R.

2946. Orientation of Crystals, Especially Quartz, by Means of Etch-Figures. C. Gaudefroy. *Comptes Rendus*, 192. *pp.* 1113–1116, *May* 4, 1931.—The method makes it possible to orientate any fragment of quartz devoid even of any crystal face, and determine the position of its axis with an accuracy of 1°. It depends on a consideration of the relative positions of the faculæ and luminous lines produced by the reflection of a point source of light from the etch-figures. The faculæ are caused by reflection from facets of which those of the forms $\{2\bar{1}\bar{1}\}$ and $\{411\}$ are always present; the luminous lines join two facets. C. A. S.

2947. Figures Obtained with Etched Crystalline Plates. A. de Gramont. *Rev. d'Optique*, 10. *pp.* 213–222, *May*, 1931.—A quartz plate cut perpendicular to the optical axis, when one of its faces is etched with HF, will show in certain patches a number of trihedra, with constant orientation. When a point source of light is observed through the plate, placed close to the eye, a virtual image, with ternary symmetry, is observed; this image is caused by the elementary trihedra, and reproduces their characteristics. The image is shown to be due to light transmitted through the reflecting surfaces, when there is so-called total reflection. Such images can be observed with different crystalline plates; they give a much magnified statistical representation of orientated elements. H. N. A.

2948. Arrangement of Atoms and Ions in Crystals. M. L. Huggins. *J. Phys. Chem.* 35. *pp.* 1270–1280, *May*, 1931.—A summary with examples and illustrations of the principles by means of which the relative positions of ions and atoms in crystals are determined. C. A. S.

2949. Space-Group of Potassium Dithionate. W. H. Barnes and G. V. Helwig. *Canad. J. of Research*, 4. *pp.* 565–569, *June*, 1931.—An X-ray investigation of the space-group of potassium dithionate is described. Approximate measurements of refractive indices and specific rotatory power were in harmony with those obtained by Groth. From Laue photographs and the fact of optical activity, the crystal class is trigonal trapezohedral, in agreement with crystallographic data. The crystals showed the single cross and circular concentric rings characteristic of uniaxial crystals when plates perpendicular to the c axis were examined under crossed Nicols in convergent polarised light. The sign of the double refraction as determined with a quarter-wave plate was positive. The primitive translations of the unit cell, determined from the a axis and c axis rotation photographs were: a_0, 9·77 Å.; c_0, 6·28 Å., and $a:c = 1:0·644$. The number of molecular units per cell was found to be three. It is deduced that the lattice must be hexagonal (Γ_h). From the fact that no abnormal spacings of {0001} were observed, the space-group of potassium dithionate is shown to be either D_3^1 or D_3^2. AUTHORS.

2950. Division of Planes and Coordination Number. F. Laves. *Zeits. f. Krist.* 78. 3–4. *pp.* 208–241, *June*, 1931.—The general problem is to determine the conditions under which it is possible to fill a plane with regular polygons, leaving no gaps. It is found that, when all restrictions are complied with, there are only 11 different possibilities. Polygons with more than six edges, hexagons, cannot occur. Application to crystal lattices leads to a topological interpretation of coordination number. It is interesting to note that an environment containing coordination number 5 is possible under the given limitations. The whole treatment only deals with planes and could thus only be of use crystallographically in the smectic state, *i.e.*, in two-dimensional lattices. [See also Abstract 1459 (1931).] F. I. G. R.

2951. Focal Conic Texture in Mesomorphic Substances. G. and E. Friedel. *J. de Physique et le Radium*, 2. *pp.* 133–138, *May*, 1931.—The focal conic texture of the smectic and cholesteric-nematic stases (*i.e.*, of mesomorphic substances containing parallel equidistant surfaces) is shown to be the necessary result of the fact that the cyclides of Dupin are the only surfaces the two sheets of which can both be reduced to lines, these lines being necessarily a group of focal conics. A focal surface not so reducible would involve discontinuity of structure and is thus impossible. The parallel surfaces are only cyclides within the focal domains, which cannot fill all space, hence the limitation of the focal conic texture to such domains; elsewhere the surfaces assume other forms. A texture with concentric spherical surfaces is, contrary to Oseen's view, impossible as not being reducible to lines. Spherolites cannot, and indeed do not, have a simple spherical structure, but one much more complex. (The word " stase " is proposed to indicate a structural state of matter passing discontinuously into another state, *e.g.*, crystalline → smectic → nematic → amorphous stases.) [See Abstract 2169 (1931).] C. A. S.

2952. Physical Properties and Classification of Mesomorphic States. G. and E. Friedel. *Zeits. f. Krist.* 79. 1–4. *pp.* 1–60; *Disc.*, 289–307, 1931. *In French.* This paper contains a very comprehensive discussion of mesomorphic states (Lehmann's liquid crystals) and their classification. For the same substance the reversible transformation from a crystalline to a mesomorphic state and thence to an amorphous

condition is always produced by rise of temperature, and the following series may be discerned: crystalline state (one or several), smectic state, nematic state and amorphous state. Observations of texture with the polarising microscope are described and discussed, and crystal orientation is investigated. Diffraction, orientation by electric and magnetic fields and mobility are also considered. Every mesomorphic state, whether pure or a mixture, has qualitatively the same physical properties, and exhibits the same textures as a pure body. Plates are included of p-ethyl azoxybenzoate, p-azoxyphenetole, and amyl cyanobenzalamine cinnamate in various states. A comprehensive *Discussion* takes place with **G. Foëx, C. W. Oseen, H. Zocher** and **P. P. Ewald.** H. H. Ho.

2953. Chemistry of Liquid Crystals. D. Vorländer. *Zeits. f. Krist.* 79. 1–4. *pp.* 61–89, 1931.—This paper discusses in detail, with comprehensive examples and illustrations, the shapes of molecules, the energetics of the molecule, amorphous and crystalline condition (amorphous and crystalline resins and lacquers), different degrees of crystallinity (monotropy and enantiotropy), super-crystallinity, polymorphism of liquid crystals, isomorphism and mixed crystals, circular pleochroism, and finally the character of double refraction and uniaxial directivity. As a final opinion it is stated that perhaps the secret of the liquid crystal does not lie in a one, two or three dimensionality, but in a mixed-dimensional configuration under predominance of at least one dimension.. H. H. Ho.

2954. Experimental and Theoretical Basis of Swarm Formation in Liquid Crystals. L. S. Ornstein. *Zeits. f. Krist.* 79. 1–4. *pp.* 90–121; *Disc.*, 308–318, 1931.—This paper contains the proof for the swarm hypothesis in the theory of liquid crystals. It is assumed that the liquid molecules not only exert attracting and repelling central forces, but that they also exert force pairs on each other which depend on the distance and are effective, like molecular forces in general, only over small distances. The subject matter is dealt with under the titles: light dispersion in liquid crystals; influence of a magnetic field on the permeability (extinction); influence of magnetic and electric fields on the dielectric constant; effect of the boundary wall; and the kinetic basis of the swarm hypothesis. The paper is mathematical throughout. A *Discussion* follows in which **C. W. Oseen, K. Herrmann, H. Zocher, M. Jezewski** and **W. Kast** take part. H. H. Ho.

2955. Optics of Mesophases. H. Zocher. *Zeits. f. Krist.* 79. 1–4. *pp.* 122–133; *Disc.*, 318–325, 1931.—The optics of homogeneous and inhomogeneous mesophases are discussed with examples and reviews of previous work in the field. A *Discussion* follows by **C. W. Oseen** and **G.** and **E. Friedel.** H. H. Ho.

2956. X-Ray Investigations of Liquid Crystals. Part II. K. Herrmann and A. H. Krummacher. *Zeits. f. Krist.* 79. 1–4. *pp.* 134–145; *Disc.*, 325–331, 1931.—Continues the work of Part I [see Abstract 3742 (1930)] and deals in particular with phenetole-azoxybenzoic acid allyl ester, which is examined in the amorphous, liquid-crystal and solid-crystalline phase. The last-named phase exhibits very strong Debye-Scherrer rings. Two rings appear in the liquid phase for copper radiation. The ring diameters are temperature dependent. The paper is illustrated with numerous photographs, and includes a Bibliography of literature on the subject. A *Discussion* with **G.** and **E. Friedel** is appended. H. H. Ho.

2957. Dielectric Constants and Magnetic Susceptibilities of Liquid Crystals. W. Kast. *Zeits. f. Krist.* 79. 1–4. *pp.* 146–172; *Disc.*, 331–337, 1931.—The first paper, which concerns dielectric constants, deals with dielectric anisotropy for symmetrical and unsymmetrical molecules, and with their dipole moments. Treatment of the latter includes the temperature dependence of the dielectric constants, the determination of the dipole moment, and the Born theory. The second paper, which investigates magnetic susceptibility, first contains a proof of diamagnetic anisotropy and then considers the orienting effect of a magnetic field with the dependence on temperature and field strength. A *Discussion* follows in which **L. S. Ornstein, H. Zocher** and **J. Errera** take part. H. H. Ho.

2958. Theory of Anisotropic Liquids. C. W. Oseen. *Zeits. f. Krist.* 79. 1–4. *pp.* 173–185; *Disc.*, 291–296, 1931.—In this mathematical paper the author discusses the temperature dependence of anisotropic liquids, flowing and liquid crystals, and the smectic and nematic phases. In the *Discussion* the author criticises the viewpoint of G. and E. Friedel concerning the physical properties of the mesomorphic state. Replies by **G.** and **E. Friedel** follow. H. H. Ho.

2959. Symmetry Groups of Amorphous and Mesomorphic Phases. C. Hermann. *Zeits. f. Krist.* 79. 1–4. *pp.* 186–221; *Disc.* 337–344, 1931.—This paper is intended to be a basis for a molecular theory of the mesomorphic phase. It deals first with statistical translations of simple and combined types including Fourier development and Röntgen effects; and then with statistical symmetry operations. The latter include a survey of the non-crystallographic symmetry groups and chain. All possible geometrical intermediate states between the regular molecule structures and the Schoenflies-Fedorow crystal lattice are discussed, the X-rays proving a discriminant between the various configurations. A *Discussion* follows to which **H. Zocher** and **P. P. Ewald** contribute and deals with ideal and physical structures. H. H. Ho.

2960. Mesomorphic and Colloidal Systems. W. Ostwald. *Zeits. f. Krist.* 79. 1–4. *pp.* 222–254, 1931.—This very comprehensive paper commences with an historical survey of the subject. It is shown that mesomorphic bodies are neither homogeneous nor heterogeneous, but disperse systems like colloidal assemblages. Experimental characteristics are proposed for distinguishing mesomorphic systems. Dispersoidics and phase exceptions are discussed at length and experimental definitions laid down. Mesomorphic systems are then classified according to the number of components from one onwards, fused and solution forms being distinguished. Organic and inorganic mesomorphic systems are next surveyed at length, and a distinction is drawn between mesomorphic substances and substances in the mesomorphic state. The form, order and particle size of the structure and texture element of mesomorphic systems are discussed in detail, together with the changes of texture produced by alterations of temperature, concentration and external additions. The degree of dispersity in mesomorphic systems is investigated and relationships between colloidal and mesomorphic systems considered (viscosity and electrophoresis). The final section deals with automesomorphic and accidental mesomorphic systems, *e.g.*, liquids with anisodimensional particles of different sizes in boundary layer, hydrodynamic, magnetic and electrical fields. H. H. Ho.

2961. Double Refraction of Thin Anisotropic Liquid Layers in the Magnetic Field. V. Fréedericksz and V. Zolina. *Zeits. f. Krist.* 79. 1-4. *pp.* 255–267, 1931.—It is shown that the double refraction observed in the magnetic field with thin anisotropic liquid layers may be quantitatively calculated on the assumption that the action of the magnetic field arises through the diamagnetic anisotropy of the liquid assemblage, and that the effect of two neighbouring assemblages may be calculated according to a law of Ornstein and van Wijk. For characterising the active forces within the layer, constants have been determined for four different substances (acetoxybenzolazine, *p*-azoxyanisole, *p*-azoxyphenetole, and *p*-anisolazine) at different temperatures. The observations show that these constants depend on the temperature and are very similar for the particular substances in question. H. H. Ho.

2962. First Report of the Committee on Atomic Weights of the International Union of Chemistry. G. P. Baxter, (Mme) M. Curie, O. Hönigschmid, P. le Beau and R. J. Meyer. *Am. Chem. Soc., J.* 53. *pp.* 1627–1640, *May*, 1931. *Chem. Soc., J. pp.* 1617–1627, *June*, 1931.—Moles and Batuecas have found the molecular weight of NH_3 to be 17·032, and this makes the atomic weight of N 14·009; International atomic weight (I.A.W.) 14·008. By determining the density of phosphine at different pressures Ritchie finds $PH_3 = 34·000$ and P = 30·977. The latter value is appreciably lower than the chemical one; I.A.W. = 31·02. Scott and Johnson's work on Cl (silver chloride) is mentioned. Hönigschmid and Kempter find 40·085 for Ca, slightly higher than the previous value of Richards and Hönigschmid; I.A.W. 40·08. Some work has been done by A. V. and O. Frost on calcium from a potassium felspar, and by Hönigschmid and Kempter on calcium from sylvine, to see if there is any concentration of Ca^{41} due to β-ray emission from K^{41}. Mentions analysis of vanadyl trichloride by Scott and Johnson, I.A.W. of vanadium 50·95. Gonzales using chromyl chloride has obtained an atomic weight for Cr which is only 0·01 unit higher than the current I.A.W., which is not altered. Krepelka has found 74·938 for As by analysing arsenic trichloride, Aston's value 74·927, I.A.W. 74·93. Tantalum chloride and bromide have been analysed by Krishnaswami; average atomic weight of Ta 181·36, which has been adopted by the Committee. The value 186·31 found for Re by Hönigschmid and Sachtleben has also been adopted. Tl was determined by an analysis of thallous bromide (Hönigschmid and Striebel); atomic weight 204·390, I.A.W. 204·39. Baxter and Bliss have determined the atomic weight of two different specimens of RaG (radio-lead). One of these has a lower atomic weight than any other specimen examined, and seems to consist almost entirely of Pb^{206}. H. N. A.

2963. Intensity of Molecular Beams. A. Ellett and R. M. Zabel. *Phys. Rev.* 37. *pp.* 1112-1119, *May* 1, 1931.—A Pirani gauge sensitive to pressure changes of the order of 10^{-8} mm. of mercury has been developed [see Abstract 2899 (1931)] and used to measure the intensity of molecular beams defined by two circular openings, one 0·4 and the other 0·6 mm. in diameter placed 25 mm. apart. The gauge is situated 40 mm. from the last opening. A beam of air gives a galvanometer deflection equivalent to 600 cm. with a pressure of 0·5 mm. of mercury behind the first opening. Under similar conditions H_2 produces a deflection of 1800 cm. The galvanometer sensitivity is 11·6 mm. per microvolt. The time lag

of the gauge is less than the period of the galvanometer (7 sec.). The limits within which the beam-forming system may be expected to give a Maxwellian distribution of velocities are discussed. The final pressure in the gauge due to a given beam depends upon the dimensions of the gauge opening as kinetic theory predicts. The reduction in intensity of a beam of H_2 by collision with either air or H_2 present in the experimental chamber at various pressures has been measured. The data show that the gauge may be used to measure mean free paths and to obtain more detailed information than has previously been possible as to the probability of scattering through various angles by collision. AUTHORS.

2964. Molecular Association. J. A. Wehrle. *Phys. Rev.* 37. *pp.* 1135–1146, *May* 1, 1931.—To study the molecular association of nitrobenzene, the dielectric constant of mixtures of this substance with benzene (nonpolar solvent) and polar liquids (ethyl ether, chlorobenzene and acetone) was measured. The molar polarisations of the two polar substances were calculated as a function of the concentrations. If the dependence of the molar polarisation of one polar liquid on the concentration of the other is taken as a measure of the association, the experiments show that the larger the electric moment of the molecule, the stronger is the association. They also show that association takes place not only between the molecules of a given substance, but also between two substances that may be quite different, provided they are both polar. AUTHOR.

2965. Quantum Mechanics of Collision Processes. E. U. Condon. *Rev. Modern Physics*, 3. *pp.* 43–88, *Jan.*, 1931.—The author adopts Dirac's formulation of the theory of quantum mechanics and gives a concise re-statement of the formal rules. The significance of operators is discussed and applied to a general treatment of one-dimensional collisions. The part played by electrons, protons, atoms and molecules in collisions is discussed in detail. A collision is taken simply to mean the near approach of any two of these entities, the distance between them being very great before and after this approach. Born's approximation method is criticised on grounds of convergence, and an alternative method is given. A few special one-dimensional calculations are carried out and the results are compared with those of experiment. An account is then given of the work of Faxén and Holtsmark on central fields of force in three dimensions. Scattering in a Coulombian field is also considered, and methods involving the use of wave-packets are reviewed. In an *Appendix* **P. M. Morse** deals with the more complex problem of the scattering of electrons by crystal lattices. H. L. B.

2966. Quantum Theory. A. Carrelli. *Pont. Accad. Sci., N. Lincei, Mem.* 15. *pp.* 1–200, 1931.—A comprehensive treatise. After an introduction the paper divides into three parts. Part I, the preparatory period, the discontinuity of energy, Planck's theory, the photoelectric effect, specific heats, fluctuations of radiant energy. Part II, Bohr's theory, the H atom, problems with more degrees of freedom, the principle of correspondence, perturbations, more complex spectra, X-ray spectra, the multiplicity of the more complex spectra, magnetic behaviour, the periodic system, the intensity of spectral rays, band spectra, experimental confirmation of Bohr's theorem and limits of its applicability, developments of the theory of

quanta of light. Part III, the quantistic problem, mechanics of matrices, perturbations, de Broglie's material undulations, Schrödinger's theory, the physical meaning of Schrödinger's interpretation, experimental confirmations, the statistical interpretation, the new statistics, shocks, the relation between the two quantic mechanics, the relativist equation and the rotating electron in undulatory mechanics, the problem of several bodies in the new mechanics, the quantification of radiations, the relations of uncertainty in the new quantic mechanics, conclusions. The mathematics is kept throughout as simple as possible. A. D.

2967. Recent Quantum Theories. R. J. Seeger. *Nat. Acad. Sci., Proc.* 17. *pp.* 301–310, *May*, 1931.—A short survey is given of a dissertation by the author written in 1929. A symbolic algebra is described and the fundamental symbols used are then interpreted firstly as operators and secondly as matrices. Certain weaknesses in the matrix interpretation are pointed out, chief among them being the question of convergence, the inapplicability of the matrices to cyclic coordinates and the tediousness of calculating matrix elements. Hence the author concludes that the operational interpretation of the mathematical structure of the new quantum theories is physically, and above all logically, preferable to the matrix interpretation. H. L. B.

2968. Heisenberg's Relation. H. L. Brose and E. H. Saayman. *Phil. Mag.* 11. *pp.* 980–986, *April*, 1931.—The authors point out that the foundations of quantum mechanics have been unnecessarily obscured by the treatment given in many papers and text-books on the subject. They criticise the general procedure of *assuming* the Heisenberg relation and then solving the problem of the linear oscillator. They reverse this procedure by adopting Bohr's frequency condition, regarding it as sufficiently verified spectroscopically, and then solve the problem of the oscillator by making use of the definition of ordinary matrix multiplication only. The calculations show that the Heisenberg rule can be *derived* and is a special case of the general problem. H. L. B.

2969. Theory of Radiation. W. Heisenberg. *Ann. d. Physik*, 9. 3. *pp.* 338–346, *May* 2, 1931.—A method of treating radiation problems is described which links up much more closely with the picturesque (*anschaulich*) ideas of the classical theory and of wave mechanics than those hitherto used. The starting point is not Hamilton's function nor the corresponding equation in configuration space, but the equations of motion, that is, Maxwell's and Dirac's wave equations. The cases considered include the change produced in atoms by incident radiation, the radiation emitted by atoms, the light scattered by atoms, and the interaction of electrons in an atom, all of which admit of short and simple solutions. H. L. B.

2970. Possible Action of Radiation on Atomic Nuclei. G. I. Pokrowski. *Ann. d. Physik*, 9. 4. *pp.* 505–512, *May* 7, 1931.—The greater part of such an effect, if it exists, cannot theoretically be due to absorption of the radiation, and the action of a quantum must be such that it loses no energy. It must start an exothermal process, and there may even be an increase in the energy of radiation. Since the dimensions of a nucleus are not greater than the radius of an electron in the classical theory it is scarcely correct to speak of movements of discrete particles inside the nucleus. The author considers the nucleus

as built up of a system of differently charged concentric spheres, some positive and others negative. On this basis he shows that exothermal processes of atomic disintegration will be accelerated by radiation, and that the effect will always be positive. It is not possible to say much as to the magnitude of the effect, but it cannot be large, particularly for soft rays, unless these are resonance effects. H. N. A.

2971. Non-Existence of Spin in Photons. A. Kastler. *J. de Physique et le Radium*, 2. *pp.* 159–164, *May*, 1931.—The principle of selection of the azimuthal quantum and the parallelism established by wave mechanics between electrons and photons suggest the idea that there is spin in the photons corresponding to that of the electrons. It is possible to imagine a relation between the orientation of the axes of the corpuscular spins and the polarisation state of the associated wave. Observations of the absorptions of the σ components in the transverse Zeeman effect, however, provide a crucial experiment for or against the existence of spin of the photons; it was first carried out by R. Frisch, using a resonance line of mercury and gave a negative result, indicating that the photon has no spin. The author has repeated the experiment, using the D lines of sodium, and has confirmed the result of Frisch. There are irreducible differences between the two kinds of corpuscles, photons and electrons; they have certain common properties: mass, quantity of movement, internal vibration ruled by the universal postulate $E = h\nu = mc^2$, but it is only the electron which has an electric charge, a kinetic moment and a magnetic moment. H. N. A.

2972. General Coordinate-Invariant Equations of Wave Mechanics. W. Alexandrow. *Zeits. f. Physik*, 68. 11–12. *pp.* 813–823, *April* 20, 1931.—The general coordinate-invariant equations of material waves are established. These contain the gravitational potentials. The flux-vector of the material wave taken in conjunction with the definition of velocity and acceleration establish the connection with ordinary mechanics. It is then shown that these equations correctly describe the behaviour of material waves in the gravitational field. Motion in a weak gravitational field and, in particular, hyperbolic motion in a weak central field at a sufficient distance from the centre are investigated; Newton's equation of motion and the law of gravitation are deduced for this case. H. L. B.

2973. Equation for Moments and Virial in Dirac's Wave Mechanics. S. Gupta. *Zeits. f. Physik*, 68. 7–8. *pp.* 573–576, *April* 7, 1931.—Deduces the equations for impulse moment and virial from Dirac's four equation systems by a method similar to that recently adopted by Sen [see Abstract 1105 (1931)] in obtaining the relativistic impulse energy equations. It is found that the classical expression for the impulse moment must be completed by a term which corresponds to the spin of the electrons. The final equation obtained is the wave-mechanical analogue of the virial law of the mechanics of particles. H. N. A.

2974. Relativistic Wave Mechanics. Part I. W. Elsasser. *Zeits. f. Physik*, 69. 1–2. *pp.* 1–18, *April* 23, 1931.—Continuous group theory is applied to discuss the kinematics of the Lorentz group, comprising rotation and translation, and the results are applied to Dirac's equations. J. S. G. T.

2975. Extension of the Principle of Indeterminateness for the Relativistic Quantum Theory. L. Landau and R. Peierls. *Zeits. f. Physik*, 69. 1-2. *pp.* 56–69, *April* 23, 1931.—Through consideration of the possible methods of measurement it is shown that all physical magnitudes which occur in wave mechanics cease to be capable of definition in the region where relativity becomes of importance, that is, for rapidly moving electrons, light quanta and material particles. This agrees with the known fact that wave-mechanical methods break down in this region, giving, in Dirac's relativistic equation states with negative mass, two energy values with a given impulse, infinite energy density and negative energy. In the true relativistic quantum theory, which as yet does not exist, there can be no physical magnitudes, and no measurements in the wave-mechanical sense. A system can, however, be brought into reciprocal action with any piece of apparatus, and the question asked what will be the action of the apparatus. The theory will give a probability for the result of this experiment; this, however, cannot be interpreted as the probability for a parameter of the system examined. This way of looking at the matter is confirmed by the fact that the β-spectra of the radioactive nuclei are continuous, although it can be concluded that their duration of life is the same, and that the nuclei are not in different states. If all the β-particles had the same energy, the phenomenon could be regarded as a measurement the result of which was capable of prediction. H. N. A.

2976. Supplementary Principle in Quantum Electrodynamics. M. Born. *Zeits. f. Physik*, 69. 3–4. *pp.* 141–152, *May* 1, 1931.—Difficulties in the theory of quantum electrodynamics, associated more especially with the limiting infinite value of the eigenenergy of the electron or proton and the zero energy of empty space, are shown to be associated with the assumption of the electron as a *point* charge. The author attempts to remove these difficulties by a modification of the expression for the Coulomb potential of the electron. The main conclusion of the modified theory is that just as an oscillator is characterised by a point of zero energy, and a hydrogen atom by a basic non-radiating condition associated with definite energy, so non-radiating conditions, associated with finite energy, characterise empty space. These conditions denote either the existence of electrons, protons or nuclei, or the zero condition of oscillation of the electromagnetic field. Each such condition has a characteristic radius or wave-length defined as the scattering parameter in the Gaussian distribution function denoting the zero wave groups. In the phase space, a definite cell corresponds to each class of particle. It is assumed that in the coalescence of two particles, the squares of these scattering parameters are additive in character. The theory gives a value for the relative masses of the electron and proton which is of the right order of magnitude. J. S. G. T.

2977. Problem of Motion in Field Physics and Electron Constants. M. Mathisson. *Zeits. f. Physik*, 69. 5–6. *pp.* 389–408, *May* 12, 1931.—In continuation of previous work [see Abstract 2588 (1931)], unique values of the potential of the field are derived when matter in motion is conceived as a singularity in the field. Approximate forms of the field equations are developed, the assumption being made that a surplus of equations of motion cannot occur. The problem of conservation is conceived as a set of conditions of integrability relating to charge and mass

passing through the field. Cosmological consequences of the theory and the significance of electronic charge and mass are briefly discussed.
J. S. G. T.

2978. Inner Degrees of Freedom of the Electron. V. Fock. *Zeits. f. Physik*, 68. 7–8. *pp.* 522–534, *April* 7, 1931.—It is shown that Dirac's electron, in addition to the three ordinary external degrees of freedom (the components of the impulse) and the spin which characterises its magnetic properties, has a second internal degree of freedom. This is responsible for negative values of the energy, and can be regarded as a rotation in a fictitious space. In the case of a constant magnetic field representations can be found for the operators which describe this degree of freedom, which hold for all values of the time *t*. In addition, for the free electron, the spin matrices can be represented explicity as functions of the time. By finding average values one is brought back to Pauli's theory of the spin. Schrödinger has recently shown that the second internal degree of freedom corresponds to a trembling of the electron. The author finds that this trembling is due to the rotation mentioned above. It also appears that only the second internal degree of freedom, and not the spin, is a relativistic phenomenon. H. N. A.

2979. Metrical Theory in Relation to Electron and Proton. H. T. Flint. *Roy. Soc., Proc.* 131. *pp.* 170–177, *April*, 1931.—Kaluza and Klein have shown that it is possible to give to electromagnetic forces a geometrical interpretation similar to that of gravitational forces in the theory of relativity by assuming the existence of a five-dimensional continuum. The present author starts by giving certain values to the coefficients of the element of the five-dimensional continuum. The equation for the geodesic in this continuum is written down with the help of a relation defining the momentum. It is shown that in five dimensions matter becomes the exact analogue of the photon in four dimensions. The author obtains the first-order equations of the quantum theory by writing down the equations analogous to Maxwell's equations for the five-dimensional continuum. This method of deriving the equations leads to the conclusion that the continuum has a definite metrical property, which gives rise to certain consequences. H. L. B.

2980. Electron Theory of the Ether, Light, Electromagnetism and Gravitation. A. Véronnet. *R.G.E.* 29. *pp.* 651–660, *April* 25, *and pp.* 702–710, *May* 2, 1931.—The author assumes that the ether consists of a uniform distribution of similar electrical particles, each slightly absorbing the repulsive forces between other particles and so possessing a screening property. He asserts that such an ether is stable and has no contradictory properties. The conditions necessary for the propagation of a disturbance with the velocity of light are determined. By considering a hydrogen atom immersed in such a medium it is proved that unperturbed electrons do not radiate energy. The Bohr formula for the radius of an orbit and the laws of spectral series are deduced. Maxwell's displacement becomes a real displacement of particles, and magnetic lines of force become stream lines. The presence of atoms of matter in the ether causes a very slight dilatation of the neighbouring ether particles and this is necessary and sufficient to account for gravitation. To matter in motion such an ether offers no resistance, but causes a flattening of electronic orbits. That is, the Lorentz-Fitzgerald

contraction is physically real, and the negative results of the Michelson-Morley experiment can be explained without having recourse to relativity. The recent work of Courvoisier and Esclangon concerning the existence of a fixed direction in space is supported. H. L. B.

2981. Relativistic Synthesis of Field Theories. R. Zaycoff. *Ann. d. Physik*, 9. 6. *pp.* 715–732, *May* 28, 1931.—A unified field theory, embodying the principles of "gauge"- and "limb"-covariance (Eich- und Beinkovarianz), in addition to the customary principle of covariance, is developed. J. S. G. T.

2982. Unified Field Theory. Parts V and VI. T. Y. Thomas. *Nat. Acad. Sci., Proc.* 17. *pp.* 199–210, *April, and pp.* 325–329, *May*, 1931.—Part V contains a further discussion of the existence theorem developed in Part III [see Abstract 1476 (1931)]. The exceptional case is now treated, when the data of the problem are given over a characteristic surface. It is shown that an infinite set of integrals h_a^i of the field equations exist, such that each set of integrals and their first derivatives assume the same values over one of these characteristic surfaces. In Part VI it is shown how the characteristic surfaces of the field equations can be identified with the wave-surface of a disturbance propagated with unit velocity. The bicharacteristics of these surfaces are light rays and are also the geodesics of zero length of the space. The paper concludes with a discussion of the determination of the structure of the continuum by the assignment of data in a system of local coordinates. G. C. McV.

2983. Einstein's Theory of Distant Parallelism. R. Zaycoff. *Zeits. f. Physik*, 69. 5–6. *pp.* 428–430, *May* 12, 1931.—The author removes a difficulty contained in his previous papers [see Abstract 1809 (1931)] and refers to the inadequacy of the unified theory. J. S. G. T.

2984. Path of a Particle in Configuration Space. Z. Horák. *Comptes Rendus*, 192. *pp.* 1203–1205, *May* 18, 1931.—The line element of the configuration space of the motion of a particle according to classical mechanics is found, and some properties of the path are developed. G. C. McV.

2985. Motion of Light in the Expanding Universe. M. v. Laue. *Preuss. Akad. Wiss. Berlin, Ber.* 7. *pp.* 123–131, 1931.—Starting from the generalised form of Maxwell's equations, the author shows that the usual Doppler formula for determining the motion of an object in the line of sight from the displacement of spectral lines holds in an isotropic spherical universe whose radius varies with the time. The energy of a light wave is not conserved, but varies inversely as the radius of the universe. From this it can be shown that the ratio of the brightness of an object as seen by an observer in a curved universe of constant radius to the brightness for corresponding positions of object and observer in a universe of variable radius varies inversely as the ratio of the fourth powers of the respective radii. This result affects in a slight degree the determination of the distance of a star from a knowledge of its absolute magnitude. G. C. McV.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

2986. Thermal and Dynamical Conditions for Ice Formation in Running Water. O. Devik. *Geofysiske Publ.* 9. 1. [100 *pp.*], 1930. *In German.*—The problem of ice formation is considered first from a physical point of view. Radiation processes are treated first, and involve the radiation incident upon and reflected and absorbed by the water, ice and earth's surface and the effect of topography upon these. Evaporation from and convection in the water, and conduction in the water, ice and earth affect the temperature at any given place. The changes between kinetic and other forms of energy and the flow of the stream modify these results, and calculations are made for the temperature changes on a long track and the time of transport of the water. Ice formation is examined from static and dynamic points of view. For the former the temperature of the upper surface of the ice, the temperature gradient in the ice and the heat loss from it are used to obtain conditions for the changes in ice thickness, corrections being applied for absorption of heat and changes in the energy flow of the water. The modification of these conditions by a snow covering is examined. For the dynamic side the formation of drifting ice and ice dams in open or partially open running water and ground ice is investigated. Finally, these results are applied to conditions investigated experimentally in Norway along the Österdalen during the winters 1925–1929 when temperatures, rates of flow of the stream, rates of ice formation and its disappearance in the spring were measured. R. S. R.

2987. Zinc Sulphide Method of Measuring Ultra-Violet Radiation and Results of Observations on Baltimore Sunshine. Janet H. Clark. *J.O.S.A.* 21. *pp.* 240-247, *April*, 1931.—A method was used involving the darkening of a fresh ZnS paste to 50 % of its initial reflecting power. The annual variations of the noon readings of solar ultra-violet radiation for direct sunlight and for the north sky light are given for a period of three years at Baltimore over the region 290–350 mμ, while for the therapeutic radiation they are given for two years over the region 290–315 mμ. The latter in direct sunlight at noon is 500 ergs/cm.^{2}sec. in December and 6000 ergs/cm.^{2} sec. in July, while for the north sky light the respective values are 300 and 2100. Comparison of the results with those of Coblentz and Earp shows a good agreement. The results also support the views of Dobson and Buisson regarding the annual changes in the effective depth of the ozone layer in the atmosphere.

R. S. R.

2988. Diffused Solar Radiation in the Maritime Alps. L. Gorczynski. *Comptes Rendus*, 192. *pp.* 1119–1122, *May* 4, 1931.—Diffused radiation from a clear sky at Thorenc (Alpes Maritimes, 1200 m.) for the five brightest days in February and March, 1931, averaged respectively 11 and 12 % of the total as compared with averages at Nice of 17 and 15 % during these months in 1929, and 13 and 10 % in 1930.

C. A. S.

2989. Night Sky of Exceptional Brightness and Distinction between the Polar Aurora and the Night Sky. (Lord) Rayleigh. *Roy. Soc., Proc.* 131. *pp.* 376–381, *May* 1, 1931.—An exceptionally bright

night sky on Nov. 8, 1929, is described, with photometric observations. It was of about four times the ordinary brightness and eight times the minimum ever observed. It was of the same chromatic constitution as usual, and the auroral line was not conspicuous. There was no accompanying magnetic disturbance. This is contrasted in detail with the aurora of May 14, 1921. Spectra of the aurora and of the normal night sky are reproduced for comparison. Nitrogen bands are absent in the latter. Two unidentified bright lines in the night sky spectrum are remeasured. The wave-lengths found are 4419 and 4168 Å. AUTHOR.

2990. Ozone in the Upper Atmosphere and its Relation to Meteorology. G. M. B. Dobson. *Nature*, 127. *pp.* 668–672, *May* 2, 1931. *Discourse delivered at the Royal Institution, March*, 1931.—A summary of existing knowledge. The amount of ozone in the atmosphere is equivalent to a layer 3 mm. thick at 0° and 760 mm. It is closely related to pressure at all heights, and to the density of the air at 15 km. The formation of cyclones is associated with large differences thereof in adjacent regions. In spring its amount is a maximum, in autumn a minimum, in both hemispheres, both maxima and minima at the poles are from double to treble those at the equator. It is probably formed by some action connected with the aurora, and in the area where found. It absorbs all solar radiation of wave-length less than 3000 Å., this absorption causing the temperature of the atmosphere at 50 km. to be about 400° Abs., and thus explaining the abnormal audibility of explosions at over 200 km. C. A. S.

2991. Photoelectric Spectrophotometer for Measuring Atmospheric Ozone. G. M. B. Dobson. *Phys. Soc., Proc.* 43. *pp.* 324–338; *Disc.*, 338–339, *May* 1, 1931.—The instrument measures by means of a photoelectric cell and thermionic amplifier the relative intensity of two wave-lengths isolated by a double quartz monochromator, one strongly, the other very slightly, absorbed by ozone (3110 and 3265 Å.). This suffices for measurements with direct sunlight or the light from the zenith blue sky. For measurements on thinly clouded days the relative intensity of a pair of wave-lengths both slightly absorbed by ozone (3265 and 4435 Å.) is also required. The instrument and theory thereof are described in detail. Measurements are possible with clouded sky when the sun is more than 12° above the horizon, and when much lower with a clear sky. C. A. S.

2992. Atmospheric Detonations and Solar and Terrestrial Disturbances. A. Nodon. *Comptes Rendus*, 192. *pp.* 1047–1049, *April* 27, 1931.—Detonations of the nature of Barisal guns heard at Bordeaux on Feb. 16, 1931, coincided with the outbreak of a large sunspot, and were immediately followed by severe atmospheric and magnetic disturbances. The possibility of connection is mooted. **E. Esclangon** (*ibid.*, pp. 1049–1050) regards this as improbable. C. A. S.

2993. Composition of the Interior of the Earth. A. A. Bless. *Nat. Acad. Sci., Proc.* 17. *pp.* 225–229, *April*, 1931.—Assuming the known mass of the earth and its moment of inertia as given by its known precessional constants the core would have a radius half that of the earth itself and with a constant temperature gradient the core would be at 100,000° C. The resulting thermal agitation would suffice to remove the outer shell of mono-, di- and trivalent atoms, while the collision of these

of approximate integration is given, but not actually resorted to. The total intensity is calculated from the absorption coefficient on various assumptions as to the nature of the absorbing layer; the results are all in nearly equally good agreement with the observations. The total intensity of very faint lines is proportional, in the simplest cases, to the number of resonators; that of strong lines is proportional in all cases to the square root of the number of resonators, and of the mean damping constant. In between, the intensity varies considerably more slowly. The region of transition from one law to the other depends on the Doppler effect, and is thus different for different atomic weights; a mean atomic weight of 55 is used in the calculations, since most of the elements concerned belong to the iron group. Comparison of the extreme parts of the curves allows a calculation of the number of resonators and of the mean damping constant separately; the latter is found to be about nine times larger than for a classical oscillator. It is now assumed that the theory of Weisskopf and Wigner can be extended to include the effect of radiation, by the hypothesis that absorption (and also forced emission) from either the initial or the final state will broaden a line; direct calculation for two magnesium triplets shows that absorption in the end state could actually multiply the damping constant by a considerable factor. For lines stronger than about two on the Rowland scale the intensity is a function of the effective damping constant, and Russell's calibration can be correct only for some mean value. R. d'E. A.

3003. Astrophysical Test of the Weisskopf-Wigner Theory of Line-Width. A. Unsöld. *Zeits. f. Astrophysik*, 2. 3. *pp.* 199–208, *April* 1, 1931.—The high transition-probabilities for the Lyman lines make the difference between the old and the new theories of line width particularly large for the Balmer series. Since with hydrogen all the transition probabilities involved are known, the actual contours of the lines can be calculated for any case in which the total number of atoms in the 2-quantum state is known independently. Previous work of the author's gives us this figure for the sun, and the calculation is now performed. Comparison with the observed contours is possible in spite of the disturbing effect of collisions, because the Balmer lines (especially Hα) behave very nearly like resonance lines, for which, according to Schwarzschild, pressure effects disappear in limb-spectra. Photometric observations of the first four Balmer lines are described, and contours are given for the centre and for the limb of the sun. The observed limb-contours agree fairly well with the calculations for Hα, and somewhat less so for Hβ; in all cases the older quantum theory would give much worse agreement. The theory is also applied to two Ca+ doublets, correcting an earlier calculation. R. d'E. A.

3004. Convection in the Sun's Atmosphere. Part II. Thermodynamics of Sunspots. A. Unsöld. *Zeits. f. Astrophysik*, 2. 3. *pp.* 209–213, *April* 1, 1931.—Following on a previous theory [see Abstract 74 (1931)] of the stability of convection currents, an upper limit is calculated for the adiabatic cooling to be expected in a sunspot. A reason is also given for expecting this limit to be reached as a rule. The observed sunspot temperatures agree well with the figure thus obtained. R. d'E. A.

3005. Molecular Spectra in Sunspots. R. S. Richardson. *Astrophys. J.* 73. *pp.* 216–249, *May*, 1931.—An investigation of the molecular spectra in sunspots (especially between $\lambda\lambda$4500 and 5500), since the

Revised Rowland Table gives only the atomic line intensities. Definite evidence is found for SiF only among the halogens (probably because of its high heat of dissociation and the abundance of silicon in the sun); of ZrO, very weak lines of the λ6474 band are present in the spot spectrum; it is probable that AlO is present in spots, and there is good evidence for AlH in the spectra both of spots and the reversing layer; no positive statement can be made about molecular hydrogen in spots, nor about any compound of Yt; ScO seems definitely absent in spots; MgH is definitely present in both spots and reversing layer, but TiO is confined to spots. In no star have *both* the TiO and the Swan bands of carbon, C_2, been seen together—the two appearing mutually exclusive, but the author finds that both the TiO and C_2 bands appear in the sunspot spectrum (stellar class about Ko) in about equal intensity; probably this is due to the high dispersion used upon the sun. A table is given of the bands definitely or tentatively identified in celestial spectra with notes and references. The temperatures of sunspots and of the reversing layer are found by three methods: spots (I) $4900° \pm 600° K$, (II) $4900° \pm 750° K$, (III) $4500° \pm 400° K$; reversing layer (I) $6000° \pm 700° K$, (II) $5700° \pm 1600° K$, (III) $5300° \pm 400° K$. These agree well with results found by Pettit and Nicholson, and by Russell using other methods, but their close accordance is probably accidental in view of the large probable errors. A. S. D. M.

3006. Frequency Curve of Sunspots. H. Ludendorff. *Zeits. f. Astrophysik*, 2. 5. *pp.* 370–382, *May* 26, 1931.—The influence of the relative number of sunspots at maximum on the time-variation of the sunspot frequency curve is discussed. If this number is higher than the average the maximum itself is accelerated, and so are the following minimum and maximum. If the number is lower, the reverse is the case. It is also shown that the relative number of sunspots is connected with differences in alternate sunspot cycles, which, in turn, is correlated with the twenty-three year magnetic cycle of the sunspots. G. C. McV.

3007. Study of Solar Corona Outside Eclipse. B. Lyot. *Bull. Astronomique*, 6. 7. *pp.* 305–316, 1930.—The author gives a history of attempts at this in the past. His own researches were made in July and August, 1930, at the Observatory on Pic du Midi (altitude 2860 m.), above two-thirds of the atmosphere, and in south latitude 43° giving long opportunities for observing the sun when high in the sky. The prominences (red in colour as in an eclipse) could be seen without the aid of spectrum or colour screen. In these conditions he has succeeded in analysing the polarisation of the inner corona, and in studying two brilliant rays. When the seeing was best a faint halo could be seen, due in part to diffusion in the atmosphere, but in part to the inner corona. The measures were made when the sun was 50° above the horizon; beyond 7′ from the limb there was no polarisation, but from 6′ to 3′ it increased rapidly; from 3′ to the limb it was stationary; it was strong in proportion to the clearness of the atmosphere, any cloud or haze obliterated it, indicating that it was not atmospheric. Diagrams give the proportions of polarised light in different position angles. On July 30 and the following days a brilliant green ray was seen not far from the E-line, and was most intense in the N.W., feeble in the S.E., and scarcely visible in the N. and S.; it was most brilliant where polarisation was strongest. On August 3rd and 4th was seen a brilliant red ray between the band α and C. These two rays coincided with the intense lines seen in eclipse at λλ5303·1 and 6374. A. S. D. M.

3008. Potsdam Eclipse Expedition to Sumatra (1929). Part II. Photographic Photometry of the Corona. H. v. Klüber. *Zeits. f. Astrophysik*, 2. 4. *pp.* 289–327, *April*, 1931.—The three plates obtained with the Zeiss astrograph during the eclipse, intended primarily for deflection measurements, give also very good pictures of the corona. They were provided with an intensity scale before development, and were measured up with a visual photometer in Potsdam. The possible sources of error are discussed, and the variation of relative intensity in the corona is shown in a mean isophotal diagram. A formula for the decrease of intensity with increasing distance from the sun is obtained, and is compared with previous results of other workers. Bergstrand's formal division into equatorial and polar corona is applicable, and the designation of the type of corona according to Ludendorff's system is also carried out. For Part I see Abstract 2198 (1931). R. d'E. A.

3009. Electric Field, Atmosphere and Effective Temperature of the Sun. R. Gunn. *Phys. Rev.* 37. *pp.* 1129–1134, *May* 1, 1931.—The study of important electromagnetic effects in the solar atmosphere undertaken in previous papers is continued [see Abstract 1837 (1931)]. It is shown that the large observed spread of effective temperatures of the sun's radiation can be accounted for by the presence of electric and magnetic fields in the solar atmosphere. The magnitude of the electric field at a level where the magnetic field is 25 gauss, calculated from the observed spread of temperatures, is found to be 0·015 volt/cm. and agrees well with 0·013 volt/cm. calculated earlier from the observed anomalous motions of the solar atmosphere. Gravitational equilibrium is found to be unnecessary in all regions of the atmosphere, and it is shown that the "support" and stability of the chromosphere and its anomalous eastward motion are evidences of precisely the same electromagnetic mechanism. An electric field of the value given above is shown to account qualitatively for certain bright line spectra in the chromosphere of the sun. The strange observed relation between bright line spectra and rapid axial rotation of stars, just pointed out by O. Struve of the Yerkes Observatory [see Abstract 2215 (1931)] confirms in a striking manner some of the conclusions of this and earlier papers. AUTHOR.

3010. Highly Collapsed Configurations of Stellar Mass. S. Chandrasekhar. *Roy. Astron. Soc., M.N.* 91. *pp.* 456–466, *March*, 1931.—It is shown that in Milne's collapsed configurations of stellar models composed of degenerate gas [see Abstract 1140 (1931)] the central temperatures become so large that relativistic degeneracy sets in and the equation of state changes to $p = k_2\rho^{4/3}$ (p = pressure, ρ = density, k_2 = constant). This new equation of state is introduced into the equations of stellar equilibrium, and a complete linear sequence of steady states is worked out for a given small luminosity as the mass varies. The relativistic degenerate model is an $n = 3$ Emden polytrope. If the model is entirely relativistic, and the solution is such that there is no singularity at the origin, the mass must be less than a certain critical value, M_3. On the other hand, if the model is to consist entirely of degenerate gas, the mass must be less than a second critical value, $M_{3/2}$. If $M \leq M_{3/2}$, the distributions are Emden polytropes (of degenerate gas), $n = 3/2$. If $M_{3/2} < M < M_3$, there is a degenerate gas envelope with a relativistic core. If $M > M_3$, there is a relativistic envelope with a homogeneous core, the density in this core

being the maximum density of matter. If M is infinite, the model is entirely homogeneous. G. C. McV.

3011. Equations of Fit in Stellar Structure. E. A. Milne. *Roy. Astron. Soc., M.N.* 91. *pp.* 479 482, *March*, 1931.—A discussion of Cowling's and Strömgren's result that if, in a star model, the solution in the perfect-gas envelope is centrally condensed, then the solution in the degenerate-gas core is also centrally condensed, so that there is an infinite density at the centre [see Abstract 2630 (1931)]. Two suggestions for overcoming this difficulty are made. Firstly, the equation of state may change in such a way that a region is found in which a solution without a singularity at the centre can be fitted on to the centrally-condensed solution of the region external to this one. Secondly, the opacity in the perfect-gas envelope and the degenerate-gas core may be different. In this case, to any centrally-condensed solution in the envelope there can be made to correspond a solution without central singularity in the core, by choosing the opacities in an appropriate manner. G. C. McV.

3012. Disturbances in Atmospheres of Stars. P. Guthnick. *Preuss. Akad. Wiss. Berlin, Ber.* 2. *pp.* 22-26, 1931.—A comparison of the "photoelectric" brightness of α Lyræ and the radial velocity of the star, obtained at intervals of a few minutes during the night of October 3, 1930, yields the result that variations of the brightness are accompanied by changes in radial velocity. The absence of any periodicity in these changes leads to the conclusion that they are due to disturbances in the atmosphere of the star. This explanation is further supported by the fact that the various spectral lines, from whose variations the radial velocity is determined, appear to be unequally affected by the changes of the velocity. G. C. McV.

3013. Ionisation in Atmospheres of Long-Period Variable Stars. Emily M. Hughes. *Harvard Coll. Obs., Bull. No.* 882, *pp.* 23–28, *April* 1, 1931. —The relative intensity of the ionised and neutral calcium lines, H (3968) and 4227, is examined for different period phases of twenty long-period variables. The intensities range from zero, when the line is indistinguishable from the continuous background, to 15, which corresponds to 225 of Dunham's frequency units. A definite correlation is found to exist. For late K or M spectrum variables the lines of ionised calcium have a definite maximum at maximum light, but neutral calcium lines have a definite minimum at the same phase. The results are empirical. Graphs are given for the ionisation of calcium of stars in order of period (90 to 500 days). At maximum the spectra have the definite characteristics of giant stars, but at minimum the H and K lines become indistinct. Estimates are made of the intensity of the band head of titanium oxide at 4762, and show a close parallel to that of 4227. This estimated intensity of titanium oxide is much weaker for dwarfs than for giants of the same spectral class. There is no apparent correlation for the curves of ionisation with those of the period or light, nor of the total line strength of neutral or ionised calcium with the period. Typical giants, however, have slightly stronger total calcium than typical dwarfs. A. S. D. M.

3014. Stellar Mean Proper Motions. H. Mineur. *Bull. Astronomique*, 6. 7. *pp.* 281–304, 1930.—The author gives stellar velocity as the result of four factors: (1) V_1 equal and opposite to the sun's, (2) V_2, Oorts' differential velocity; (3) V_3, a velocity of constant direction and depending

on the distance from the galactic plane; (4) V_4, residual velocity. The author examines V_2 and V_3; he transforms V_2 into V_2', so that $\bar{v}$ (mean radial velocity) remains unchanged, and $\bar{\mu}^2$ (mean proper motion) is the same as Oorts', with the addition of a constant $(B - A) \cos b / 4 \cdot 74$, indicating simply that there is a sliding of the galactic layers in the direction $l_0 = +90°$, whose value depends on the distance of the stars from the plane perpendicular to the direction, $l = l_0$, $b = 0$, and passing through the sun. The existence of V_3 has been determined directly [see Abstract 796 (1931)]. He computes the theoretical values of $\mu_\alpha \cos \delta$ and μ_δ, and finds the centre of rotation from μ_α and μ_δ, and that the values of l_0 from these are systematically superior by 20° to those from radial velocities and proper motion in galactic longitude; similarly the values of P are four times greater. He shows that this is due to the second asymmetrical current (V_3). This does not, however, explain the differences $(X_\alpha - X_\delta)$, $(Y_\alpha - Y_\delta)$ observed. Oorts' term does not fix the curve of the stars' trajectory, but the second asymmetrical current (V_3) indicates a sliding of the galactic layers parallel to the direction l_3, and depending on the distance z of the stars from the galactic plane. V_2 gives l_0 as 240° or 330°, but V_3 indicates 240°. The solution depends on the terms $\sin 3(l - l_0)$ in radial velocities, and $\cos 3(l - l_0)$ in proper motions in longitude. Dyson, Greaves, Wilson and Raymond have shown that such terms exist, and thus point to the adoption of $l_0 = 240°$. A. S. D. M.

3015. Short-Period Changes in the Radial Velocity of Vega. A. Belopolsky. *Zeits. f. Astrophysik*, 2. 4. *pp.* 245–253, *April* 23, 1931.—Radial velocities were measured on a number of evenings, usually from 5–8 exposures on any one evening, with a 3-prism spectrograph. The change in radial velocity in the course of an evening is appreciable, and almost all the observations can be combined into a curve of period 0·1795 day, with an amplitude of ± 2 km./sec., and a general form resembling that of the Cepheids. Some lines occasionally showed bright edges, and some seemed to have variable intensities. R. d'E. A.

3016. Photography of Faintly Luminous Areas of Different Colours. J. Stobbe. *Zeits. f. Astrophysik*, 2. 3. *pp.* 182–198, *April* 1, 1931.—Primarily a study of the conditions to be fulfilled if the "dark nebulæ" observed visually by Hagen are to be photographed. The Piper rule and the Purkinje effect are discussed, and a considerable amount of experimental material is presented, dealing with the sensitivity of different brands of plates in various regions of the spectrum. It is shown that the attempts that have been made to photograph these nebulæ are inadequate; the sensitivity of the eye for moderately extended areas has not been reached. Methods of increasing the photographic sensitivity are discussed. R. d'E. A.

3017. Completion of Hagen's Catalogue of Nebulous Clouds. F. Becker. *Pont. Accad. Sci., N. Lincei, Atti.* 84. *pp.* 308–310, *April* 19, 1931. *In German.*—Hagen intended to observe all the diffused nebulosities in the sky, from the north pole to 20° south declination, and had accomplished the greater part of this work when he died in 1930. It has now been completed by the writer, and the whole will be published shortly. The general result is shown in a chart on which the nebulosities are plotted according to galactic coordinates, and their relative darkness is indicated by darker and lighter shadings. It is at once apparent that their distribution is a function of galactic longitude as well as latitude. Towards the

poles the shading is darkest, but within 20° of the equator light shading or none (that is, clear sky) is most common. But there are dark regions here also, especially two, in Taurus and in Ophiuchus, where visible stars are few. Specially clear regions exist in parts of the northern galaxy which are richest in stars, *viz.*, Aquila to Cassiopeia, Monoceros and Sagittarius. Between 90° and 140° galactic longitude, where the galaxy is less bright, the background also is somewhat dark. The distribution therefore is closely correlated with the distribution of telescopic stars, and directly opposed to the frequency of interstellar matter as observed by Trumpler and others. But it is possible that some of the nebulous clouds do not absorb starlight as strongly as others. Counts of stars and of their magnitudes should be made, so as to determine how far atmospheric influences, contrast, etc., affect the results; and Hagen's observations should be repeated in some place less disturbed by street lighting than Rome. M. A. E.

3018. Rotation of Large Magellanic Cloud. M. Kaburaki. *Phys. Math. Soc., Japan, Proc.* 13. *pp.* 151–156, *May*, 1931. *In English.*—The author divides the Cloud by a great circle which separates objects showing radial velocities (in km./sec.) of + 292 to + 309 above the circle from those of + 251 to + 275, and finds that it is moving as a whole towards the point $A = 5^h\ 13^m{\cdot}0$, $D = +\ 0°\ 23'$ with a velocity of 777 km./sec. Comparing the radial velocities, computed and observed, of each object, he forms a table of O − C which indicates that the Cloud rotates about an axis (the above great circle) with an angular speed per year of $0''{\cdot}0015$ (or a rotation period of $8{\cdot}5 \times 10^8$ years). Further dividing the objects into four groups, of which I and IV may be taken as the exterior region of the Cloud, II and III as the interior, he finds the relation $P = 2\pi cr(V - V_m)^{-1}$, where P is the number of years, and gives it the form $\omega = 0{\cdot}6875(V - V_m)r^{-1}$, where ω is the angular speed of rotation per year. The values for the exterior and interior regions respectively are found to be: V_m (in km./sec.), $278{\cdot}5 \pm 3{\cdot}0$ and $274{\cdot}2 \pm 3{\cdot}3$; ω, $0''{\cdot}0029 \pm 0''{\cdot}0005$ and $0''{\cdot}026 \pm 0''{\cdot}005$; P (in years), $(4{\cdot}5 \pm 0{\cdot}9) \times 10^8$ and $(5{\cdot}1 \pm 1{\cdot}3) \times 10^7$: indicating that the speed of rotation in the interior is much larger than in the exterior, which is consonant with Lindblad's theory of spiral structure for anagalactic nebulæ. The author thus confirms the theory of R. E. Wilson rather than that of Hertzsprung. A. S. D. M.

3019. Planetary Nebulæ. Part II. H. Zanstra. *Zeits. f. Astrophysik*, 2. 5. *pp.* 329–344, *May* 26, 1931.—This paper is devoted to the parallaxes and to the rates of expansion of nebular envelopes of the planetary nebulæ. An empirical law between the photographic brightness of the nebula and the temperature of the central star is established. The brightness of the envelope, together with the value of the galactic rotation, then leads to approximate values of the distance, and of the radii of the star and envelope, of the nebula. The doubling of the N_1 line in the spectrum of certain nebulæ is interpreted as due to the expansion of the envelope. The velocity of expansion of the nebulæ discussed is found to be of the order of 16 km./sec., but one velocity of 1200 km./sec. was also found. G. C. McV.

3020. Reflection Effect in Eclipsing Binaries. E. W. Pike. *Astrophys. J.* 73. *pp.* 205–215, *May*, 1931.—By means of approximations, the equations of Milne for re-radiation from stellar surfaces are applied to close binaries. The variation of the reflection effect with phase is computed

and a more accurate approximation than the one in present use is proposed. The exaggerated darkening at the limb shown by the secondary disc, as seen at secondary minimum, is illustrated and its possible effect on solutions of the light-curve discussed. An approximate correction to the spectroscopically determined masses of a binary, to account for the asymmetrical lighting of the secondary, as seen at quadrature, is computed. A large discrepancy between the computed and observed absolute magnitudes of the reflection effect is illustrated and discussed. AUTHOR.

3021. Point-Source Model with Variable Opacity. B. Strömgren. *Zeits. f. Astrophysik*, 2. 5. *pp.* 345–369, *May* 26, 1931.—The opacity of a perfect gas star-model, with a single source of energy-generation at the centre, is taken equal to $k_1\rho/T^{7/2}$ (ρ = density, T = temperature), and the solutions are classified. Taking fixed values of the star's total mass, luminosity, radius and molecular weight of the matter, the solutions are classified after Milne, as collapsed, Emden, and centrally condensed according to values of the constant k_1. It is also shown that in a composite model consisting of a perfect gas envelope and a degenerate gas core, if the solution in the envelope is centrally condensed, so is the solution in the core. The values of the coefficient of opacity are discussed, and it is shown that, on this model, the coefficient of opacity is still greater than its theoretical value. G. C. McV.

3022. Relation between Period and Amplitude in Light Changes of Cepheid Variable Stars. B. Sticker. *Zeits. f. Astrophysik*, 2. 5. *pp.* 389–395, *May* 26, 1931.—It has long been known that with Mira variables a correlation exists between amplitude and period. This is true also for Cepheid variables with periods longer than one day, and also for the class intermediate between Mira stars and Cepheids, with periods of from 45 to 91 days. The relation is such that if the period is increased 2·5 times, the visual amplitude increases by $0^m\cdot2$. The relation cannot be affirmed for Cepheids with periods of less than one day, and for Mira stars it differs in degree, for, according to Ludendorff's figures, if the period is increased 1·5 times, the amplitude increases by one whole magnitude. M. A. E.

3023. Extension of Giant Sequence to Low Masses. E. W. Pike. *Astron. J.* 41. *pp.* 73–79, *May* 6, 1931.—It is shown, by a study of a certain class of eclipsing binaries of the "giant and dwarf" type, that the secondary stars of each pair form a group which extends the giant sequence to stars with masses as low as one-fourth that of the sun. The criterion for the "giant" character of these stars is their low density. Details of mass and density for a large number of binaries are given. The paper concludes with a discussion of the possible origin of these binaries. G. C. McV.

3024. White Dwarfs and Limiting Density of Matter. D. S. Kothari. *Phil. Mag.* 11. *pp.* 1130–1133, *May*, 1931.—The theory of white dwarfs whose matter is at absolute zero is further developed by taking into account, in the condition of equilibrium, the volume that is excluded by each electron for interaction with other electrons. It then follows that, for any given mass of a star, there is an equilibrium configuration. There is a definite maximum density, for given mass, which the matter of the star can attain, and also a lower limit to the density of a white dwarf star. G. C. McV.

LIGHT.

3025. Filters for Sunlight and Daylight Reproduction and Colour Temperature Determination. R. Davis and K. S. Gibson. *Bureau of Standards, Misc. Publ. No.* 114. [165 *pp.*], 1931.—A two-compartment cell with three borosilicate crown-glass windows filled with two solutions A and B has been found to give the best results, to be permanent, and to have spectrometric properties easily reproducible. The components of solution A are copper sulphate, mannite, pyridine and water; and of B, copper sulphate, cobalt ammonium sulphate, sulphuric acid and water, of which the first pair in each case may be varied in amount to fulfil the required conditions. Extensive spectrophotometric measurements have been made to verify Beer's law and to obtain the best combinations of source and filter for the required energy distributions. The paper contains 33 figures and 26 tables, showing energy distribution, spectrophotometric, colorimetric data, and so forth. A source-filter combination is described to give the same energy distribution as a Planckian radiator from 1600° to 20,000° K. The filters are further described in 38 charts. H. M. B.

3026. Definition of Saturation. C. Schaefer and H. Pese. *Phys. Zeits.* 32. *pp.* 381–382, *May* 1, 1931.—A reply to a paper of the same title by Seitz [see Abstract 1855 (1931)]. **W. Seitz**, *ibid.*, p. 383, makes further comments. C. B. A.

3027. Transparency of Sodium Fluoride and Lithium Fluoride in the Extreme Ultra-Violet. E. H. Melvin. *Phys. Rev.* 37. *pp.* 1230–1232, *May* 15, 1931.—Artificially prepared single crystals of sodium and lithium fluorides were tested for transparency to extreme ultra-violet light by means of a 1-m. concave grating vacuum spectrograph. The source used was a highly-condensed spark discharge through a Pyrex capillary. These crystals were expected to be more transparent than calcium fluoride (fluorite), due to their lower indices of refraction. Lithium fluoride was transparent to 1083 Å. (132 Å. below the limit of fluorite) which is the practical limit to be expected. Sodium fluoride was transparent to 1320 Å., which is not thought to be the limit of the pure material. Crystals of these salts have been made as much as 5 cm. in diameter, and they are rather insoluble and easily cut and polished, being very similar to fluorite. AUTHOR.

3028. Transformation of Light into Heat in Solids. Part II. J. Frenkel. *Phys. Rev.* 27. *pp.* 1276–1294, *May* 15, 1931.—The results arrived at in a preceding paper [see Abstract 1857 (1931)] are generalised for diatomic crystals. A direct determination of the probability of light absorption in a linear lattice leads to the establishment of a selection rule amounting to the law of the conservation of momentum for the light quanta and the "excitation quanta." This rule enables one to explain the linear structure of the spectra of solid bodies at low temperatures. The preceding results are generalised and applied to a new description of the process of light scattering in crystals and the theory improved by introducing the width of the excitation lines and allowing for the damping of the exciting light waves. AUTHOR.

3029. Reflecting Powers of Rough Surfaces at Solar Wave-Lengths. H. E. Beckett. *Phys. Soc., Proc.* 43. *pp.* 227–239; *Disc.*, 240–241, *May* 1, 1931.—A study of the reflecting properties of building materials for solar radiation has been made, a hemispherical mirror being used for integrating diffusely-reflected energy upon a thermopile receiver. The paper follows the work of Coblentz and Royds, and deals at length with the errors inherent in the method and with the adjustment of the apparatus. The theory of the method is simplified by the introduction of an auxiliary specimen which, in particular, renders the observations independent of the degree of blackness of the thermopile receiver. Reflecting powers for a large number of building materials are given for four radiation bands within the solar range, and also for the composite radiation obtained by the screening of a pointolite lamp with a thin gold film. The latter radiation somewhat resembles that of the sun in range and distribution, and enables the reflecting power of a surface for total sunlight to be determined approximately in a single reading. The apparatus has been tested with magnesium carbonate surfaces, and yields reflecting powers in the visible spectrum in good agreement with those found photometrically. AUTHOR.

3030. Refractive Indices of Solutions by an Interferometer Method. W. Geffcken. *Zeits. f. Elektrochem.* 37. *pp.* 233–237, *May*, 1931.—The method depends on turning a double chamber, half filled with water and half with solution, through an angle α, so producing a shift in interference bands. The advantages of the method are greater region of measurement, simple handling and independence of results on dispersion. A theory is given to show the relation between the refractive index of the solution as compared with water and the movement of the bands. The method is regarded as an improvement on that of Pulfrich. Some details of the construction of the instrument are given. H. M. B.

3031. Measurements of Thickness under the Microscope. P. Metzner. *Zeits. f. Instrumentenk.* 51. *pp.* 243–247, *May*, 1931.—Sources of error due to (1) motion of the microscope tube, (2) transparency of the object, (3) refractive index of object and medium, (4) direction of illumination, (5) aberration produced by the objective, and (6) accommodation of the eye are discussed in turn. To reduce the errors to a minimum, the author recommends the largest possible magnification, the largest aperture for illumination, the highest accuracy of adjustment and elimination of accommodation in the micrometer eyepiece. R. S. R.

3032. Notation for Optical Diagrams in Theoretical Investigations on Refraction. J. Picht. *Zeits. f. Instrumentenk.* 51. *pp.* 265–271, *May*, 1931.—Reference is made to the recommendations of a German Commission which dealt with this subject. The author proceeds along the lines of wave theory to the general relations required for a wave surface, normals to the surface, focal planes, caustics, aberration, coma, astigmatism, etc., and, finally, suggests a series of symbols which may be applied for all these relations. R. S. R.

3033. Physical Identity of Enantiomers. A. N. Campbell. *Am. Chem. Soc., J.* 53. *pp.* 1661–1666, *May*, 1931.—Results similar to those obtained for *d*- and *l*-mandelic acids [see Abstract 430 (1931)] are furnished by *d*- and *l*-camphoric acids. T. H. P.

3034. Magnetic Rotation and Birefringence in a Liquid Traversed in any Direction by a Polarised Beam. A. Cotton. *Comptes Rendus*, 192. *pp.* 1065–1069, *May* 4, 1931.—This paper is introductory to that by Dupouy and Schérer [see following Abstract]. When a beam of light is propagated obliquely to the lines of force in a magnetic field, the magnetic rotation and the birefringence are superposed. An apparatus for observing this, used in conjunction with the large electromagnet at Bellevue, is described. The effects should be independent. If i is the angle between the incident beam and the equatorial plane of the magnet, and ω and ϕ are rotatory power and birefringence respectively, $\omega = \omega_0 \sin i$, and $\phi = \phi_0 \cos^2 i$, where ω_0 and ϕ_0 are constants. For large values of i it is not *a priori* obvious that ω_0 and ϕ_0 should be constant. From the equation $\delta^2 = 4\omega^2 + \phi^2$ for the phase difference introduced between the privileged vibrations, a geometrical construction for the phase difference between the two privileged elliptical components of an incident vibration can be deduced. Similarly it is possible to calculate the difference $n' - n''$ of the indices for the two privileged vibrations for any value of i.

C. B. A.

3035. Simultaneous Magnetic Rotation and Birefringence in a Liquid. G. Dupouy and M. Schérer. *Comptes Rendus*, 192. *pp.* 1089–1091, *May* 4, 1931.—A plane polarised vibration traversing a liquid placed in a magnetic field obliquely to the lines of force becomes elliptical, and the ellipticity is a measure of the phase difference δ between the privileged vibrations [see preceding Abstract]. Observations of the ellipticity made on *a*-bromonaphthalene, nitrobenzene and CS_2 in a field of about 43,650 gauss, for values of i ranging from $-4°$ to $+11{\cdot}5°$, show that $\frac{\phi}{\cos^2 i}$ and $\frac{\omega}{\sin i}$ are constant to about 1 %. This result is in accord with the hypothesis of Gouy, that the superposed effects are independent. The observed azimuth of the incident vibration for which the apparent birefringence is a maximum is also in agreement with the calculated value.

C. B. A.

3036. Combined Effects of the Internal Electric Field of a Uniaxial Crystal and of a Magnetic Field Normal to the Optical Axis. Circular Polarisation and Magneto-Electric Rotatory Power. J. Becquerel and L. Matout. *Comptes Rendus*, 192. *pp.* 1091–1093, *May* 4, 1931.—The changes undergone by a beam of plane polarised light in passing through a uniaxial crystal in a magnetic field normal to its optic axis are studied with xenotime at the temperature of liquid nitrogen. The frequencies of the absorbed circular vibrations and the intensities are found to depend on the orientation of the binary axes of the tetragonal crystal with regard to the field, and on the orientation of the incident rectilinear vibration to the binary axes and to the field. The circular polarisation is attributed to the (non-homogeneous) internal electric field of the crystal; the superposed magnetic field only serves to separate the vibrations of opposite sense. The rotatory power arises from the circular polarisation, and is a new phenomenon having its origin in the simultaneous influence of two fields so that it obeys laws different from those for ordinary rotatory power; and the name "magneto-electric rotatory power" is proposed for it. [See also Abstracts 2654 (1931) and 3331 (1929).]

C. B. A.

3037. Magnetic Rotations of Crystallised and Fused Quartz. A. Cotton. *Comptes Rendus*, 192. *pp.* 1166–1168, *May* 18, 1931.—In very thin plates fused silica is sufficiently isotropic for its magnetic rotatory power to be measured. A plate 0·75 mm. thick gave a corrected double rotation per mm. of $2\omega = 2{\cdot}77°$ for the yellow mercury line. In the same field, a plate of right-handed quartz, with its axis along the field, gave a value of 3·20°. Dividing by the densities, the values of $\frac{2\omega}{d}$ are 1·25 and 1·21 for fused and crystalline quartz respectively. This difference is greater than experimental error. C. B. A.

3038. Standardisation of Half-Wave and Quarter-Wave Plates. P. Lainé. *Comptes Rendus*, 192. *pp.* 1215–1218, *May* 18, 1931.—Serious errors are introduced into observations on elliptically polarised light, such as are necessary in the study of magnetic double refraction, or of circular dichroism, by small inaccuracies in the half-wave or quarter-wave analysers used. This source of error is discussed, and it is shown that, given a quarter-wave plate of sufficient accuracy, it is possible to standardise other quarter- and half-wave plates, by Chauvin's method of measuring the phase differences which they produce, with an accuracy ten times that of the method of Chaumont. C. B. A.

3039. Natural and Magnetic Rotatory Power of Some Organic Compounds in the Liquid State. C. Salceanu. *Comptes Rendus*, 192. *pp.* 1218–1220, *May* 18, 1931.—The specific rotations and Verdet's constants of molten *l*-menthol, *d*-camphor and *d*-carvone have been measured at various temperatures. The ratios of the specific rotations of molten camphor for the Hg yellow, green and violet lines are in agreement with those observed in cyclohexane solution. The ratios of the Verdet constants also agree with those measured for solutions in hexane and ether by other observers, but not for solution in ethyl alcohol. Camphor and carvone do not even approximately obey Wiedemann's rule that the ratio of Verdet's constant to specific rotation is independent of wave-length; but molten menthol appears to obey it very accurately, at least from 4360 Å. to 5780 Å. The temperature coefficients are much higher for natural than for magnetic rotation. C. B. A.

3040. Magnetic Birefringence of Liquid Hydrocarbons. M. Schérer. *Comptes Rendus*, 192. *pp.* 1223–1224, *May* 18, 1931.—The magnetic birefringence of the hydrocarbon series $C_nH_{2n} + 2$ and C_nH_n, and of some cyclic compounds, has been measured by the method of Cotton and Dupouy [see Abstract 2795 (1930)]. The birefringence increases from octane to tetradecane and is negative. From octene upwards the birefringence of the ethylenic series is also negative, but weaker. Octene itself gives a very small positive value. The saturated carbon chain therefore produces an effect of opposite sign to that of the double bond. This is confirmed by undecylene, which has two double bonds and gives a positive value; and it is also found in cyclohexane (−) and cyclohexane (+). The increasing negative effect of a saturated group attached to a benzene ring is shown in the series ethylbenzene-propylbenzene-butylbenzene. C. B. A.

3041. Intensities in Rayleigh Scattering. J. Weiler. *Zeits. f. Physik*, 68. 11–12. *pp.* 782–795, *April* 20, 1931.—The intensity distribution is measured in the unmodified lines scattered by organic liquids. The

broadening of the unmodified lines is greatest in benzene, and is dependent on the frequency of the exciting light, being greatest for the shortest wave-length. The broadening of the lines cannot be satisfactorily accounted for as unresolved Raman rotation lines. The middle of the line is characterised by an intensity peak, which can clearly be determined with a vessel with a quite black background. The extent of the broadening in different liquids goes hand in hand with the molecular anisotropy, being greatest for benzene, and less progressively for cyclohexene, cyclohexane, cyclopentane. A. C. M.

3042. Scattering of Light by Turbid Media. Parts I and II. J. W. Ryde and B. S. Cooper. *Roy. Soc., Proc.* 131. *pp.* 451–475, *May*, 1931.—In Part I a theory of the scattering of light by dense turbid media, such as opal glasses, is developed for a system composed of a large number of similar spheres of a dielectric suspended in any medium. The total transmission and reflection are shown to depend on the refractive index of the medium, the size and number of the particles and their refractive index, the wave-length of the incident light and its distribution, the absorption coefficient of the medium, and the thickness of the sheet. In Part II numerical values of the necessary coefficients are calculated. On the basis of the theory, the size and number of particles in a certain opal glass are deduced from photometric observations of its transmission and reflection. These calculated values are shown to agree with those obtained by direct observation. C. B. A.

3043. Achromatic Interference Fringes and Group Velocity. C. Schaefer. *Zeits. f. Physik*, 68. 11–12. *pp.* 764–765, *April* 20, 1931.—When interference fringes are observed with white light, *e.g.*, with Fresnel's mirrors, an achromatic fringe occurs, since for all wave-lengths the path difference is zero. This "centre" of the interference system could not be present in exactly homogeneous light. The nth bright fringe for wave-length λ will lie $\frac{n\mathrm{D}}{b}\lambda$ away, where D is the distance from sources to screen, and b is the distance between the coherent sources. Now interpose a prism between sources and screen. The prism causes a shift v, which is dependent on the dispersion. The position of the nth fringe is now $u = v(\lambda) + \frac{n\mathrm{D}\lambda}{b}$. The achromatic fringe lies at the place where u is independent of the wave-length, *i.e.*, where $\frac{du}{d\lambda} = 0$. This gives $n = -\frac{b}{\mathrm{D}}\frac{dv}{d\lambda}$ and $u = v - \lambda\frac{dv}{d\lambda}$, which is identical with the Rayleigh formula for the connection between group velocity u and wave velocity v. This is because the interference system is a "group" with an identifiable "centre," the achromatic fringe. It is to be observed that the interference case deals with a shift, and not with a velocity as in the analogous case. A. C. M.

3044. Making of Mirrors by the Deposition of Metal on Glass. *Bureau of Standards, Circ. No.* 389. [17 *pp.*], 1931.

3045. Slit with Special Means of Fine Adjustment. H. Lorenz. *Zeits. f. Astrophysik*, 2. 5. *pp.* 396–398, *May* 26, 1931.—Description of a slit, designed by the writer and made by Toepfer of Potsdam, for use with a vacuum grating spectrograph for exact measurements of wave-length.

The position of the slit can be altered in any of the three dimensions, and the precise amount of alteration read off on scales. Illustrated by two photographs. M. A. E.

3046. Method of Producing Monochromatic Images of Luminous Objects with Extended Surfaces. H. Strebel. *Zeits. f. Astrophysik*, 2. 5. *pp.* 383–388, *May* 26, 1931.—An apparatus is described which, by spectral filtering, produces a monochromatic image of a luminous object in any colour. The light emerging from a telescope is resolved by a spectrograph system and a portion of the spectrum, selected with a movable slit, passes through a second identical optical system placed in the reversed position. A monochromatic image is thus obtained, the colour purity depending on the dispersion employed and on the width of the selecting slit. The slit of the first spectrograph can be replaced with advantage by a pin-hole screen. C. B. A.

3047. Heterochromatic Photometry with the Pulfrich Stereophotometer. J. Jaumann. *Zeits. f. Physik*, 69. 3–4. *pp.* 153–184, *May* 1, 1931.—The author first examines the underlying principles of heterochromatic photometry, and states that in order that the criterion of equality of brightness of two fields may have the essential characteristic of giving unique results, it must lead to a single value for the ratio between two given field brightnesses, whatever the colour steps used intermediately. By this criterion he examines various methods of heterochromatic photometry, including the Pulfrich stereophotometer, in which the criterion of equality is straightness of the apparent path of a moving object illuminated simultaneously by the two lights to be compared. This method is found to satisfy the criterion above described, within the assessed accuracy of observation with this instrument. Individual comparisons are much more precise, however, with the flicker photometer or the ordinary steady comparison method. J. W. T. W.

3048. Discharge Tubes as Standard Photographic Light Sources. F. v. Göler and M. Pirani. *Zeits. f. techn. Physik*, 12. 3. *pp.* 142–148, 1931.—Discusses light standards hitherto in use or projected for photographic sensitometry, in particular the use of an incandescent lamp *plus* filter to simulate " mean noon sunlight," now being investigated in connection with the International Congress of Photography. The ultra-violet transmission of the filters is of first importance, and has been least investigated; likewise the variation in ultra-violet emission of the source with age of the lamp, while the spectral distribution of the primary emission is very sensitive to changes in the applied voltage. The use of a helium discharge-tube has been suggested (Nutting, 1907), but many more suitable vapours or gases may be chosen, less prone to " poisoning " by foreign adulterants, and with a voltage-sensitivity only about one-tenth that of an incandescent lamp. An account is given of a number of these, including a tube employing a specific mixture of Hg, Cd and Ne, the discharge through which, like that through CO_2, closely resembles daylight. Such combinations may be used to determine the spectral distribution of emulsion sensitivity. L. V. C.

3049. Photographic Method for Securing Copies of Diagrams, etc., Without the Use of a Camera. E. J. Haverstick. *Rev. Sci. Instruments*, 2. *pp.* 287–289, *May*, 1931.—The figure to be copied was covered with a sheet of 5 in. × 7 in. Azo F=5 single weight paper with

the sensitised surface in contact with the page, care being exercised to insure intimate contact over the whole surface. Using a 60-W frosted bulb in a dark lamp at a distance of approximately 8 in., exposures of the order of 2 to 3 min. were required, the light passing through the sensitised paper to the page to be copied. The paper, after developing and drying, was used as a negative, in the usual way, to secure positive prints. An explanation is given of the formation of the negative by passing the light through the sensitised paper, and references are given to H. E. Durham's work in the same field (*British Journal of Photography*, Jan, 9, 1931).

H. H. Ho.

3050. Depression of Density Produced by Bromide in the Development of Photographic Emulsions. A. P. H. Trivelli and E. C. Jensen. *Kodak Research Lab. Comm. No.* 452. *Frank. Inst., J.* 211. *pp.* 335–347, *March*, 1931.—The density depressions due to soluble bromide in the developer are determined for ciné-positive and ciné-negative emulsions, for exposures to light and to X-rays, and for development in pyrogallol and in hydroquinone developers. The depressions are generally less for light than for X-ray exposures, the difference becoming more pronounced as the time of development increases; the results are more consistent with Abegg's theory of the depression of Ag̊ concentration than with any other. Two main depression factors may be distinguished: (1) difference in sizes of developable centres; and (2) distribution of developable centres through the thickness of the photographic layer. The distribution is uniform for X-ray exposures, while there is a superficial concentration for light exposures, the development of which will be less influenced by soluble bromide produced during the development process itself than in the former case. L. V. C.

3051. Size-Frequency Distribution of Residual (Undevelopable) Grains in a Photographic Emulsion. E. C. Jensen and A. P. H. Trivelli. *Frank. Inst. J.* 211. *pp.* 489–494, *April*, 1931.—Size-frequency data obtained by Wightman, Trivelli and Sheppard [see Abstract 1012 (1924)] are analysed, the data representing the distribution of (undeveloped) grains in a simple emulsion both before exposure and after eleven successive exposure steps. At any stage in the exposure the size-frequency is represented by a formula of the type, $y = Ae^{-k(\log_e x - \alpha)^2}$, but no simple means of expressing the change in the parameters A, k and α is found, the distribution curves changing in both form and position as exposure proceeds. L. V. C.

3052. Sensitisation by Desensitisers. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 30. 1–2. *pp.* 1–7, *May*, 1931.—The author first discusses the various anomalies found with sensitising and desensitising agents, and then describes experiments for the elucidation of apparent paradoxical cases. Various quantitative darkening relationships for ripening and nuclear (germ) destruction are dealt with, using chromic acid, phenosafranine, Janus green and Capri blue, four sets of curves being included. H. H. Ho.

3053. Relation of Intensity of Fluorescence to Concentration in Solid and Liquid Solutions. A. A. Dixon. *J.O.S.A.* 21. *pp.* 250–258, *April*, 1931.—The observed fluorescence of solid and liquid solutions of rhodamine in ethyl alcohol and collodion mixture, multiplied by the ratio of total exciting energy to absorbed energy, is found to decrease exponentially with the concentration for weak solutions. The value of k, the

multiplier in the exponent of the exponential expression, is found to be larger for liquid solutions than for solid solutions. If it is assumed that the fluorescing power is destroyed when a molecule of the active material is nearer than a critical distance p to another, then the value of p can be calculated. [See also Abstract 1200 (1931).] J. E.

3054. Sphere of Action of the Extinction Phenomena in Fluorescent Liquids. J. M. Frank and S. J. Wawilow. *Zeits. f. Physik*, 69. 1–2. *pp.* 100–110, *April* 23, 1931.—The former theory of the extinction of fluorescence in liquids is generalised by the introduction of the idea of the sphere of action, and is then compared with former and with new experiments. The measurement of the increasing polarisation which accompanies the extinction gives a convenient method for comparing the sphere of action with the kinetic sphere. It appears that the sphere of action alters (increases) with increasing viscosity of the solvent, and from this conclusions are drawn as to the effect on the extinction of the time during which the molecules act on one another. H. N. A.

3055. Absorption Spectra of Salt Solutions. (Miss) S. Kato. *Inst. Phys. and Chem. Research. Tokyo, Sci. Papers, No.* 294. *pp.* 161–162, *April* 1, 1931. *In English.*—Previous work [see Abstract 3122 (1930)] has been extended by using a fluorite vacuum spectrograph. In particular, the absorption bands of Tl^+ and Pb^{++} ions predicted at $\lambda\lambda$1760 and 1580 have been located at $\lambda\lambda$1710 and 1570 respectively. F. S.

3056. Ultra-Violet Absorption Spectrum of Hydrazine Vapour. S. Imanishi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 296. *pp.* 166–167, *April* 1, 1931. *In English.*—Five band heads between 2326–2225 Å. have been located with small dispersion, but no indication of fine rotational structure has yet been found. F. S.

3057. Absorption of Liquid and Solid Solutions of Rhodamine B in a Mixture of Ethyl Alcohol and Collodion. A. A. Dixon. *J.O.S.A.* 21. *pp.* 259–261, *April*, 1931.—Assuming that the absorption follows the law $I = I_0 e^{-kdc}$, curves have been obtained showing kd against wave-length at different concentrations. At low concentrations, two bands are shown. With increasing concentration the long-wave band becomes more prominent while the shorter wave band becomes less so. J. E.

3058. Absorption Spectra of Polyhalide Ions. F. L. Gilbert, Rose R. Goldstein and T. M. Lowry. *Chem. Soc., J. pp.* 1092–1103, *May*, 1931.—Molecular extinction coefficients are recorded for seven aromatic polyhalides of the series $C_6H_4Br.NMe_3^{\prime}$ in alcohol, for eight cæsium polyhalides in alcohol and in water, and for a series of aqueous potassium polyhalides prepared by adding free halogens to the potassium halides. The polyhalide ions from $I_3^{\prime}$ to $BrCl_2^{\prime}$ give characteristic absorption spectra, which cannot be attributed to hydrolysis, dissociation, reduction, or double decomposition. Dissociation, which is specially marked in aqueous solutions, diminishes the intensity of the strong selective absorption of the ions, but does not change the form of the absorption curves. H. H. Ho.

3059. Absorption Spectrum and Photochemical Decomposition of Hydriodic Acid. G. K. Rollefson and J. E. Booher. *Am. Chem. Soc., J.* 53. *pp.* 1728–1732, *May*, 1931.—It has been shown that the

continuous absorption of HI extends up to a wave-length of 4000 Å. instead of terminating at 3340 Å., as reported by others. The absorption on the long wave-length side of 3120 Å. has been interpreted as due to the dissociation of the molecule into normal atoms and that on the shorter wave-length side as due to a dissociation with the iodine atom excited. The intensity distribution of the absorption has been discussed with reference to the potential energy curves for the normal and excited states of the molecule. The photochemical decomposition of HI has been shown to be due to this absorption, and the mechanism of the reaction is considered. H. H. Ho.

3060. Superposition of Optical Absorption Bands and its Recognition through Optical Activity. W. Kuhn and H. K. Gore. *Zeits. f. phys. Chem.* 12. *Abt. B.* 5. *pp.* 389–397, *May*, 1931.—Measurement of the circular dichroism of the ketonic absorption band of camphor indicates that this consists of two bands which are superposed and which correspond to different electron transitions. The weaker secondary band (*Nebenband*) contributes practically the whole of the optical activity of the molecule. This band is also observed in the absorption spectra of aldehydes, and can be recognised in the spectrum of the vapour, particularly of formaldehyde. Intensity measurements show that it corresponds to a " forbidden " electron transition, which is caused by the presence of neighbouring constituents. C. B. A.

3061. Vibration Spectra of Compounds containing CCl. W. West and Marie Farnsworth. *Faraday Soc., Trans.* 27. *pp.* 145–160, *April*, 1931.—The following liquids are investigated: CH_3Cl, C_2H_5Cl, CH_2CHCl, C_3H, Cl (propyl and *iso*-propyl), and α, β and γ chloropropylene. In all the compounds, one or more strong lines are found in the region 600–700 cm.$^{-1}$, accompanied by a weaker line between 300–400 cm.$^{-1}$. These are attributed to the CCl linkage. The introduction of a double bond in the molecule effects an increase in the value of characteristic frequencies. The different characteristic frequencies of related compounds show similar degrees of polarisation. Examples are found of lines having a depolarisation factor greater than 1. Evidence is adduced tending to show that a high value of the frequency of a given linkage, where it can be interpreted as a high value of the force constant for the vibration, is associated with comparative inertness of the molecule to reactions in which an important part is the rupture of the corresponding bond. A. C. M.

3062. Infra-Red Spectra of Polyatomic Molecules. Part I. D. M. Dennison. *Rev. Modern Physics*, 3. *pp.* 280–345, *April*, 1931.—This is a theoretical exposition of the formation of infra-red spectra of polyatomic molecules, and deals in order with the spectra due to vibrational, rotational and symmetrical properties of molecules. These correspond to the spectra as revealed by instruments of increasing resolution. Electronic effects are disregarded, a stable configuration of the nuclei being assumed and the force functions acting upon them being considered. F. S.

3063. Near Infra-Red Arc Spectrum of Iodine. T. Iwama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 295. *pp.* 163–165, *April* 1, 1931. *In English.*—The spectrum was excited in a quartz discharge tube and photographed with a dense glass prism, using bathed and hypersensitised plates. Wave-lengths from 9114 Å. to 6965 Å. are tabulated and the ionisation potential given as 10·4 volts. F. S.

3064. Optical Spectrum of Polonium. A. Czapek. *Akad. Wiss. Wien, Ber.* 139. 2*a*. 9–10. *pp*. 593–612, 1930.—A special form of enclosed spark, due to Auer-Welsbach, is described in which the current and voltage can be read at the formation of the spark. Samples containing polonium were used on electrodes of copper and silver in an atmosphere of oxygen at atmospheric pressure. Allowing for the lines of impurities in the various samples, a new line has been found at 2449·99 Å. which is taken to be the ultimate line of polonium. F. S.

3065. Spectra of Beryllium, BeI and BeII. F. Paschen and P. G. Kruger. *Ann. d. Physik*, 8. 8. *pp*. 1005–1016, *April* 10, 1931.—The spectra were excited by a glow discharge in helium in a vessel whose walls were coated with beryllium. The analysis of the BeI spectrum was checked by arcs in various gases between Be electrodes. The spectra, both in air and *in vacuo*, were photographed with gratings and tables of wave-lengths and term values are given. Comparison with the work of Paton, Rassweila and Nussbaum is made in a footnote. F. S.

3066. Arc Spectrum of Rhenium. H. Schober. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 1–2. *pp*. 79–98, 1931.—The rhenium was used in the form of nitrate and the arc spectrum excited by placing on carbon poles. The spectrum from 2200–6700 Å. was photographed in the first order of a 15-ft. grating, 410 lines measured being listed. In addition, a table of chief lines is given, of which the most prominent are 3452·07, 3460·61 and 3464·87 Å. There is another at 4889·38 Å., which seems to give the characteristic blue colour to the flame. F. S.

3067. Arc Spectrum of Zirconium. C. C. and Harriet K. Kiess. *Bureau of Standards, J. of Research*, 6. *pp*. 621–672, *April*, 1931.—Nearly 1600 lines have been measured in the arc spectrum between 2085 Å. and 9300 Å., and approximately 80 % classified as combinations between terms of singlet, triplet and quintet systems. The terms are those required by Hund's theory and are confirmed by Zeeman effect observations. An ionisation potential of 6·92 volts is found for the neutral atom. The resonance lines are given by the combination $a^3F–z^5G^0$, whereas the *raies ultimes* are given by $a^3F–z^3G^0$. More than 200 Zr lines have been identified with dark lines in the solar spectrum, of which nearly half represent term combinations which do not appear in emission spectra observed in the laboratory. F. S.

3068. Resonance Radiation in Manganese Vapour. J. Fridrichson. *Zeits. f. Physik*, 68. 7–8. *pp*. 550–553, *April* 7, 1931.—The author has described [see Abstract 480 (1931)] the obtaining of fluorescence in manganese vapour due to two lines, 4032 Å. and 2798 Å., $IS–2^3P_{123}$ and $IS–2^3P'_{123}$. The components of these lines are now resolved. The resonance radiation excited by copper and silver sparks and by white light is also studied, and then only the triplet IS–2P′ appears. This excitation with sparks between electrodes of other elements can be explained either as a quantum-mechanical resonance or as due to the continuous background of the spark. A. C. M

3069. Band Spectra of Halogen Compounds of the Alkaline Earth Metals. K. Hedfeld. *Zeits. f. Physik*, 68. 9–10. *pp*. 610–631, *April* 13, 1931.—The band spectra of $CaCl_2$, $SrCl_2$, $BaCl_2$, $CaBr_2$, $SrBr_2$, $BaBr_2$ and CaI_2 have been photographed in the visible spectral region,

using the arc and the oxy-acetylene flame. In almost all cases it is possible to arrange the band heads correctly in the level schemes by making use of the measured isotropic separation of the energy of oscillation, together with the nuclear frequencies and the doublet separations; also to show that the molecules concerned in the production of the bands are diatomic, MX, where M is a metallic atom and X a halogen atom. Comparison of the band systems worked out by the author with the short wave-length ones found by Olmsted leads to the conclusion that long and short wave-length bands have as common end state a 2π term combination, while $^2\Sigma_i^?$ terms are probably concerned as excited states. The temperature of the acetylene flame is much more favourable to the excitation of these bands than the higher arc temperature. The paper contains numerous tables giving details of the band structures. H. N. A.

3070. Band Spectrum of Zinc Hydride. M. Fukuda. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 300. *pp.* 227–245, *May* 1, 1931. *In German.*—The zinc hydride spectrum has been examined. The bands of the $^2\Pi$–$^2\Sigma$ system each contain six series, of which the middle branches, P_2, Q_1, and Q_2, R_1 form close doublets; the separation increases linearly with p. The $^2\Sigma'$–$^2\Sigma$ bands consist of doublets, although in the region from 3380–2900 Å. several bands of simple structure appear. The R_1, P_1 and R_2, P_2 branches have not been resolved for small values of p, whilst only faint indications of the Q lines are present. The final state of the bands at 3219, 3381, 3053, 3200 and 2916 Å. are identical with those of the $^2\Pi$–$^2\Sigma$ system. H. F. G.

3071. Band Spectra of Calcium Hydride. Part I. B. Grundström. *Zeits. f. Physik*, 69. 3–4. *pp.* 235–248, *May* 1, 1931.—The $^2\Sigma'$–$^2\Sigma$ system has been investigated at wave-lengths between 4000 and 5800 Å. Marked irregularities are observed in the rotation structure of the $^2\Sigma'$ state. At 3–4 atmospheres hydrogen pressure a $\Delta v = -1$ group of the A bands at 7654, 7611 and 7569 Å. has been photographed. The pronounced pressure effect in the C system is ascribed to predissociation. H. F. G.

3072. Spark Spectrum of Chlorine (Cl III). K. Murakawa. *Zeits. f. Physik*, 69. 7–8. *pp.* 507–514, *May* 28, 1931.—The first spark spectrum of chlorine, Cl III, is excited in a Geissler tube by means of a condensed discharge. The spectrum is photographed with a 1 m. grating and a prism spectrograph and the wave-lengths are determined. A large number of triplet terms based on the ^4S and ^2D terms of Cl II are identified. The ionisation potential of Cl II calculated from the term values amounts to 23·70 volts. J. E. K.

3073. Anomalous Dispersion of Lithium Vapour. A. Filippov. *Zeits. f. Physik*, 69. 7–8. *pp.* 526–547, *May* 28, 1931.—The anomalous dispersion of lithium vapour in the visible and ultra-violet spectrum has been studied with the aid of the interferometer. The probability of transition is less for the second doublet than for the third, and the experimental values for the first three doublets are in close agreement with those derived by Trumpy on the basis of wave mechanics. The number of dispersion centres of all terms of the main series of lithium from the second onwards is equal to 2·9 % of the number for the first term. Of the total number of atoms, 23 % are responsible for continuous absorption. H. F. G.

3074. Notation for Lines and Terms in Atomic and Molecular Spectra. F. Hund. *Zeits. f. Astrophysik*, 2. 3. *pp.* 217–242, *April* 1, 1931.—A systematic account of the established practice, together with a survey of theoretical viewpoints involved, especially as regards the various kinds of symmetry and the most important types of coupling. Not suited for abstraction. R. d'E. A.

3075. Theory of Complex Spectra. Part II. E. U. Condon and G. H. Shortley. *Phys. Rev.* 37. *pp.* 1025–1043, *May* 1, 1931.—Works out formulæ, using Slater's method, for the relation between the energies of multiplets arising from the same electron configuration, for all two-electron configurations up to *ff*, and several cases of three-electron configurations. This first order perturbation theory is shown to agree with experiments in some cases and to differ with them in others. Details are given with regard to this behaviour. An energy table of LaII, as recently analysed by Meggers and Russell, is given. This contains complete $5d4f$ and $4f^2$ configurations, which fit the theory very well; these calculations have assisted in the assignments of some of the singlets and resulted in a rearrangement of singlet lines. [For Part I, see Abstract 1252 (1931).] H. N. A.

3076. Incomplete P′ Triplets. E. Majorana. *N. Cimento*, 8. *pp.* 107–113, *March*, 1931.—The best known anomalous triplets beyond the limits of the normal series are stable if relativistic corrections are neglected. The presence of intrinsic magnetic moments produces a slight instability which only exceptionally assumes a quantitative importance. The necessary conditions are satisfied for the component $j = 2$ of the anomalous triplets of Zn, Cd and Hg. The fact that the component $^3P_2$ of these is absent or very weak is experimentally confirmed. E. E. F. d'A.

3077. Existence of a 2-Volt Term of the Mercury Atom. V. Kondratjew. *Phys. Zeits.* 32. *pp.* 288–289, *April* 1, 1931.—Calculates the height of a supposed triplet term of the Hg atom above the ^{1}So level by two different processes. In both it comes out at 43·5 kg.-cal. or 2 volts. The fact that this term has not yet been spectroscopically discovered shows that we have probably to do with a metastable term such as the ^{3}F term. E. E. F. d'A.

3078. Relative Intensities of Mercury Lines under Different Conditions of Excitation. M. J. E. Golay. *Phys. Rev.* 37. *pp.* 821–829, *April* 1, 1931.—The relative intensities of the lines of the $2s$–$2p_i$ triplet vary with the conditions of excitation as a result of absorption of the lines at 5461 and 4047 Å. by atoms in the metastable $2p_1$ and $2p_3$ states. About 75 % of the 5461 Å. radiation and about 33 % of the 4047 Å. radiation is absorbed in a commercial three-electrode valve when a high plate current is employed. The absorption is less at low plate current or with an ordinary arc. Measurements with a specially designed valve yield values of the intensity/4th power of frequency ratio of 3·3 and 8·5 for the lines at 4358 and 4047 Å., and at 5461 and 4047 Å., respectively. The ratio for the lines at 4078 and 4047 Å. varies with plate voltage in the same manner as the variation of the efficiency of ionisation with electron velocity; this effect is attributed to the presence of two types of emission, *viz.*, that arising from excitation of the neutral atom and that due to recombination. The relative intensities of the excitation and recombination spectra indicate that recombined atoms prefer the

singlet to the triplet system, the order of preference in each system being P, S, D, and *p*, *s*, *d*, respectively. Within each state a level at about the height of the 4S level is the most favoured. H. F. G.

3079. Structure of the Excitation Function of Mercury Lines. K. Siebertz. *Zeits. f. Physik*, 68. 7–8. *pp.* 505–521, *April* 7, 1931.—Mercury vapour was excited to luminosity by slow electrons and the resulting spectrum photographed, so as to show its relation to the velocity of the electrons. The optical excitation function of single lines, in the region of the excitation potential, showed several maxima when the velocity of the electrons was varied in sufficiently small steps (0·2 volt). In explanation, it is pointed out that the initial term of a line may be arrived at, not by a direct spring from the ground state, but also by "cascade springs" after excitation of higher terms or ionisation. In the optical excitation function the sum of these possibilities is observed. The recently published work of Hanle on the excitation function of He linse, and of Schaffernicht on that of Hg lines, is mentioned, and reasons are suggested for the difference between their results and those of the author. H. N. A.

3080. Pseudopolar Reactions between H Atoms. E. Majorana. *Accad. Lincei, Atti.* 13. *pp.* 58–61, *Jan.* 4, 1931.—Discusses the X term in the spectrum of the hydrogen molecule, which according to Weizel assumes the configuration $(2p\sigma)^2{}^1\Sigma g$. The author's calculations confirm the existence of this term, although it is more likely to be a K term than an X term. E. E. F. d'A.

3081. Excitation Potential of the Continuous Hydrogen Spectrum. W. Finkelnburg and W. Weizel. *Zeits. f. Physik*, 68. 9–10. *pp.* 577–584, *April* 13, 1931.—According to Winans and Stueckelberg, the continuous spectrum corresponds to the $1s\sigma 2s\sigma {}^3\Sigma g \rightarrow 1s\sigma 2p\sigma {}^3\Sigma u$ transition, *i.e.*, to a potential of 11·84 volts, while experimental values range about 12·6 volts. An accurate determination of the potential curve shows that the latter value applies to the region about 4400 Å., that the curve sinks to 11·84 volts in the ultra-violet and then rises again. F. S.

3082. Boltzmann Distribution in the Hydrogen Arc. L. S. Ornstein, (Miss) J. G. Eymers and J. Wouda. *K. Akad. Amsterdam, Proc.* 34. 4. *pp.* 505–507, 1931. *In English.*—The spectrum of atomic hydrogen, produced between tungsten electrodes, has been studied and the intensity relationships have been measured. The Balmer lines are prominent, but the secondary spectrum of hydrogen is absent. The distribution of the energy levels conforms to a Boltzmann distribution at arc temperatures between 4900° and 6300° Abs. H. F. G.

3083. Distribution of Intensity among the Fine-Structure Components of the Series Lines of Hydrogen and Ionised Helium according to Dirac's Theory. M. Saha and A. C. Banerji. *Zeits. f. Physik*, 68. 9–10. *pp.* 704–720, *April* 13, 1931.—Dirac's theory in the form developed by Darwin and Weyl is used to calculate the transition probabilities for the fine-structure components of H_α and of the H_ε^+ line 4686 Å. The Ornstein-Burger-Sommerfeld rule for the relative intensities of the components of a multiplet is deduced from Dirac's theory. Contrary to Goldstein's results, the distribution of intensity is found to

be in good agreement with the experimental results, as has already been shown by Sommerfeld and Ornstein, who applied statistical considerations and used Schrödinger's form of wave mechanics. H. L. B.

3084. Reversal-like Phenomenon of the Balmer Lines of Hydrogen. H. Nagashima. *Tokyo B.D., Sci. Reports*, 1. 7–12. *pp.* 133–143, *May* 23, 1931. *In English.*—The self-reversal of the Balmer lines of hydrogen has hitherto been studied by many investigators, usually by the aid of Geissler tubes. In the present experiment, a similar phenomenon was observed in the spectra of the explosion under water of metallic wires, such as lead, aluminium and copper wires, or when exploded in an atmosphere of water vapour or hydrogen gas. It was found that the line H_β appears always as if it were reversed, while the lines H_α and H_γ do not show any similar phenomenon at all. This reversal-like appearance of H_β may not be regarded as an ordinary pure self-reversal; rather it seems to be well explained as mainly due to the fact that the emission line itself is affected by the interatomic and intermolecular field of ions and suffers the Stark-broadening. From this point of view a theory is developed, and the theoretical curves thus obtained are compared with the microphotometric curves. Author.

3085. Direct Measurement of Intensity Variations of Helium Lines with Voltage. J. Razek. *Phys. Rev.* 37. *pp.* 1252–1262. *May* 15, 1931.—The intensity variations with voltage of some of the brighter lines of the low-voltage helium arc spectrum were determined by means of a recently developed photoelectric spectrophotometer. The radiation was developed in a copper ball, 20 cm. in diameter. The equipotential kathode and grid from a commercial three-electrode valve formed the internal structure, the sphere itself being the anode. This arrangement gave an extremely bright spectrum, even at the striking voltage, with a relatively low current density in the space. The results on 5016 (1^1S–2^1P) and on 6678 (1^1P–2^1D) were generally smooth curves. Lines 4026 (1^3P–4^3D), 4471 (1^3P–3^3D), and 5876 (1^3P–2^3D), show a region of constant intensity with arc voltages from 27 to 35 volts, thereafter increasing smoothly. Line 4713 (1^3P–3^3S) shows definite maxima near the critical exciting potentials. The accurate linear relationship between the intensity of the light admitted to and the amplified output of the photoelectric cell was established by a separate experiment. For the measurements on the spectrum lines, every intensity measurement was referred to a standard lamp operated at a constant resistance. The absence of oscillations in the arc current was shown by a valve voltmeter. Author.

3086. Intensities of Forbidden Lines. S. Sambursky. *Zeits. f. Physik*, 68. 11–12. *pp.* 774–781, *April* 20, 1931.—The intensity sum-rules only hold for spontaneous transitions, and can therefore not be applied to forbidden transitions allowed in high electric fields. The Kramers-Heisenberg dispersion formula is used to deduce the relative intensities of the components of such multiplets, and measurements on the silver lines 2^2P–3^2P afford agreement with the deduced intensities. The general formulæ are deduced for doublets with $\Delta l = 2$ caused through dipole transitions in perturbing electric fields, and the experimental results for the copper doublet 2^2P–4^2F are in good agreement with the requirements of the theory. A. C. M.

3087. Intensity Measurements in the Copper Arc. W. B. Nottingham. *Zeits. f. Physik*, 68. 11–12. *pp.* 824–833, *April* 20, 1931.—An earlier work by the author was criticised in three respects by Ornstein and Vermeulen [see Abstract 484 (1931)]. They stated (1) that the probability of excitation of the metastable states $m^2D_{2,3}$ in the copper atom by electronic collisions is very small, (2) that for all states the maximum value of the probability of excitation lies at far higher electronic velocities than that which is just necessary to produce excitation, (3) that self-absorption must have played an important part in the author's measurements. The author states that (1) the experiments of Franck and Einsporn and of Messenger show clearly that the metastable state of mercury can be excited without difficulty, (2) a recently published paper by Michels on the excitation function of helium indicates a sharp maximum of excitation when the electronic energy exceeds the excitation potential by a small fraction of a volt, (3) new photoelectric determinations by the author, published in the present paper, show that the ratio 2:1 remains valid for the normal arc for currents between 2·0 and 6·0 amperes. H. L. B.

3088. Effect of Slit Width upon Distribution of Intensity in Spectral Lines. Part II. P. H. van Cittert. *Zeits. f. Physik*, 69. 5–6. *pp.* 298–308, *May* 12, 1931.—In continuation of previous work [see Abstract 1229 (1931)], the author shows how the "true" distribution of intensity in spectral lines may be derived from the observed "apparent" distribution. The case of a prism spectrograph with absorbing prism is discussed in some detail. In particular, it is shown that lines are considerably broadened when strongly absorbing prisms are used, and that very narrow prisms can be advantageously used in quartz spectrographs designed for use in the extreme ultra-violet. J. S. G. T.

3089. Temperature Determinations from Band Spectra. Part II. Rotational Energy Distribution in the CN and AlO Bands and Temperature Distribution in the Arc. L. S. Ornstein and H. Brinkman. *K. Akad. Amsterdam, Proc.* 34. 4. *pp.* 498–504, 1931.—The temperatures in carbon arcs in air have been measured from the relative band line intensities, using the method of Ornstein and van Wijk. The CN bands are emitted from the violet kernel of the carbon arc; the temperature in this kernel was found to be about 6500° Abs., independently of the length of arc and of the current; it seems to be the same at all distances from the electrodes. Little difference in temperature was found in the kernel for different distances from the axis of the arc, though observation through holes in the length of the arc gave 7800° Abs. in the axis of the arc. The temperature distribution in the halo of the arc was derived from the line intensities of the bands of AlO. For this the anode was bored out and filled with a mixture of carbon powder and Al_2O_3. The AlO band $0 \rightarrow 0$ gives a mean temperature of about 2950° Abs., while the $1 \rightarrow 0$ band gives about 3600°. An explanation of this difference is given. [For Part I, see Abstract 1915 (1931).] H. N. A.

3090. Hyperfine Structure of the Principal Components of Mercury Lines 5770, 5791, 5461 and 4358. H. Nagaoka and T. Mishima. *Imp. Acad. Tokyo, Proc.* 7. *pp.* 137–139, *April*, 1931. *In English.*—The authors have undertaken a further investigation of the hyperfine structure of the principal components of certain Hg lines. A Lummer-Gehrcke plate crossed with a Fabry-Pérot étalon is used for

this investigation. It is found that the principal component of λ5461 consists of four components, and that of λ4358 of two components. The principal component of λ5770 is simple and that of λ5790 is broadened. The broad components which are observed probably consist of several very close unresolved lines. Precautions are taken to eliminate self-reversal effects. J. E. K.

3091. Hyperfine Structure in the Spectra of CaII, BaII and TlI. S. Frisch. *Zeits. f. Physik*, 68. 11–12. *pp.* 758–763, *April* 20, 1931.—A search is made for hyperfine structure components of lines in the spectra of CaII and BaII. These spectra are especially interesting since they are alkali-like and can be treated by theoretical considerations which Fermi has applied to the hyperfine structure of the alkali spectra. Moreover, if these two elements have magnetic moments of the same magnitude as found for other elements, their hyperfine structure should be large enough, especially in the case of BaII, to be easily resolved by the available apparatus. Investigation of the two resonance lines of CaII and the two corresponding resonance lines of BaII reveals, however, no hyperfine structure and hence the conclusion is drawn that both Ca and Ba have nuclear moments $I = 0$. With the same Schüler hollow kathode discharge, four Tl lines are investigated. The two lines λ5352 and λ3776 are found to have a structure as given by previous investigators and lead to a confirmation of the nuclear moment $I = 1/2$. The lines λ3529, λ3519 are found to be simple. An influence of discharge conditions on the intensities of the hyperfine structure components of the resonance line 3776 is noted. J. E. K.

3092. Hyperfine Structure in Ionised Bismuth. R. A. Fisher and S. Goudsmit. *Phys. Rev.* 37. *pp.* 1057–1068, *May* 1, 1931.—The hyperfine structure of several lines in the spectra of BiII and BiIII have been determined. A method which facilitates the analysis of partially resolved line patterns is described. The level separations obtained from the analysis are compared with theoretical formulæ showing the inadequacy of the present theory for the interaction of external electrons with nuclear spin. AUTHORS.

3093. Raman Spectrum and Chemical Constitution of Chloroethylenes. G. B. Bonino and L. Brüll. *Accad. Lincei, Atti*, 13. *pp.* 275–281, *Feb.* 15, 1931.—By applying the considerations developed by Mecke [see Abstract 461 (1931)] to C_2Cl_4, the ratios of the deformation-oscillations $\delta_1 : \delta_2 : \delta_3$ are calculated to be $1{\cdot}31 : 1{\cdot}85 : 1$; the Raman spectrum of this compound exhibits three frequencies with wave-lengths $341 : 447 : 2{\cdot}34 = 1{\cdot}45 : 1{\cdot}91 : 1$. The case of the isomeric cis- and trans-dichloroethylenes is also discussed. [See Abstract 1041 (1930).] T. H. P.

3094. Raman Spectra of Calcite and Aragonite. S. Bhagavantam. *Zeits. f. Krist.* 77. 1–2. *pp.* 43–48, *April*, 1931. *In English.*—The inactive frequency has approximately the same value in the two crystals, 1087·4 (calcite) and 1087·0 (aragonite). One of the active oscillations in calcite is 717·3, while the corresponding one in aragonite is 708·1. It is concluded that the CO_3 ion structure is conserved remarkably well in the two crystals. A. C. M.

3095. Rotational Raman Spectrum of CO_2. W. V. Houston and C. M. Lewis. *Nat. Acad. Sci., Proc.* 17. *pp.* 229–231, *April*, 1931.—The Raman spectrum of CO_2 is photographed, using the gas under pressure

(75 lbs./sq. in.) in a quartz tube. The rotation band appears to be composed of equidistant lines; there is no trace of irregularities in spacing and intensity which would be produced by the presence of more than one moment of inertia. The rotational lines fit $\nu = \frac{1}{8} \times 3{\cdot}150(4J + 6)$. This shows that the rotational quantum number J changes by two units in a transition, that only even rotational states are present, and that the moment of inertia is $70{\cdot}2 \times 10^{-40}$ gm. cm^2. A. C. M.

3096. Intensities of Raman Lines. J. Rekveld. *Zeits. f. Physik*, 68. 7–8. *pp.* 543–549, *April* 7, 1931.—Measurements of lines due to methyl alcohol show that in the neighbourhood of an absorption region the intensity increases more quickly than would be expected from the fourth power law. The absorption frequency is calculated from the energy ratios of two lines, and good agreement obtained with the absorption data. A. C. M.

3097. Raman Effect in Quartz at Different Temperatures. M. J. Ney. *Zeits. f. Physik*, 68. 7–8. *pp.* 554–558, *April* 7, 1931.—The spectrum of the light scattered by a quartz crystal between 18° and 500° C. is studied. It is found that at 500° C. the Raman lines are made very diffuse, and that the shifts are less than at 18°. As the temperature increases, the anti-Stokes lines get stronger relatively to the Stokes lines, and lines corresponding to small shifts get stronger relatively to those due to large shifts. A. C. M.

3098. Raman Effect and Molecular Constitution. Part IV. B. Trumpy. *Zeits. f. Physik*, 68. 9–10. *pp.* 675–682, *April* 7, 1931.—The spectrum of silicon tetrabromide is measured and compared with that of tin tetrabromide. The vibration frequencies calculated on the basis of a tetrahedral molecule fit the observed frequencies. Mixtures of $SiBr_4$ and $SiCl_4$ give rise to no new lines, differing from the case of mixtures of $SnBr_4$ and $SnCl_4$. PCl_3 and PBr_3 are taken as examples of the type XY_3 and the four frequencies observed agree well with the requirements of a pyramidal model. Mixtures of the two give rise to new lines due to the formation of PCl_2Br and $PClBr_2$. The variations in intensity of the Raman lines show that these mixed halides are in chemical equilibrium with the pure halides. [For Part III see Abstract 1248 (1931).] A. C. M.

3099. Raman Effect of Sulphur Compounds. F. Matossi and H. Aderhold. *Zeits. f. Physik*, 68. 9–10. *pp.* 683–695, *April* 13, 1931.—The Raman spectra of S_2Cl_2, SO_2, CS_2, $SOCl_2$, SO_2Cl_2, SO_2ClOH, $OS(OCH_3)_2$, $OS(OC_2H_5)_2$, $(CH_3)_2S$, $(C_2H_5)_2S$ and CH_3, C_2H_5.S are measured. The structures of the molecules S_2Cl_2 and $SOCl_2$ are deduced from the frequencies, using Mecke's method [see Abstract 461 (1931)] and a form of Dennison's method [see Abstract 307 (1926)], and it is found that both methods lead to nearly the same structure for the two molecules, although the forms given to the vibrations are different. Mecke's division of vibrations into valence and deformation vibrations is discussed. A. C. M.

3100. Difference in the Self-Reversal of Neon Lines Excited by Direct and Alternating Currents. H. Nagaoka and T. Mishima. *Imp. Acad. Tokyo, Proc.* 7. *pp.* 140–142, *April*, 1931. *In English.*—The self-reversal of Ne lines excited by a.c. and d.c. is observed with the aid of a Fabry-Pérot étalon. For a.c. the reversal of the lines of Ne^{20} is greater than that of the lines of Ne^{22}. For all lines the reversal is greater with

d.c. than with a.c. and is greater for s_2, p-lines than for s_3, s_4, s_5, p-lines. A connection may exist between reversal and the deviation of the isotope spectra from the Bohr formula. The amount of reversal is independent of terminal voltage, but dependent on current density. J. E. K.

3101. Displacements of Certain Lines in the Spectra of Ionised Oxygen (OII, OIII), Neon (NeII) and Argon (AII). W. E. Pretty. *Phys. Soc., Proc.* 43. *pp.* 279–304; *Disc.*, 304, *May* 1, 1931.—In continuation [see *ibid.* 41. *pp.* 442–455, 1929] of an investigation of the displacements which characterise certain spectral lines produced in a discharge tube at moderate gas pressure (of the order of a few cm.), the spectra OII, OIII, NeII and AII have been studied. As in the case of NII, which has been examined previously, many lines in each of the spectra are displaced to the red, and for the majority of the lines the amount of displacement has been determined. The term shifts so obtained have been discussed in relation to the term schemes for each of the spectra. A comparison of the term shifts in the various spectra has been made, and it is found that the 4*s* terms of OII, OIII, NII and NeII, and the 5*s* terms of AII (^{3}P family) all show roughly the same shift. Some typical shifted lines have been examined with a microphotometer and the curves are reproduced. The suggestion made in the previous paper that the shift is probably a Stark effect receives further support. AUTHOR.

3102. Zeeman Effect in the Silicon Spectrum and in the Band Spectra of the Alkaline Earth Fluorides. Elizabeth v. Mathes. *Zeits. f. Physik*, 68. 7–8. *pp.* 493–504, *April* 7, 1931.—The Zeeman effect is measured of the lines $3p^3P_{012}$–$4s^3P_{012}$ and of the lines 2881 Å. and 3905 Å. of Si, and are in agreement with the allocations of Fowler in the spectrum of neutral silicon. The Zeeman effect in the spectra of the fluorides of Ca, Ba and Sr is investigated and the results compared with the theory. A. C. M.

3103. Structure and Zeeman Effect of the Neon Spark Spectrum, NeII. T. L. de Bruin and C. J. Bakker. *Zeits. f. Physik*, 69. 1–2. *pp.* 19–35, *April* 23, 1931.—A continuation of Bakker's recent paper on the same subject [see Abstract 3064 (1929)]. The previous level scheme with the limit ^{3}P is enlarged by certain terms. The theoretically possible doublet term systems, with the limits ^{1}D and ^{1}S, have been worked out. The table given of the classified NeII lines contains 280 lines. The g values of 3*s*, 3*p* (^{3}P, ^{1}D, ^{1}S) are given, and the g summation law is tested. Details are given of the Zeeman effects for 40 lines. Ionising potential 40·93 volts; this is based on the 3*s*4*s* series. H. N. A.

3104. Zeeman Effect of the Krypton Spark Spectrum, KrII. C. J. Bakker and T. L. de Bruin. *Zeits. f. Physik*, 69. 1–2. *pp.* 36–51, *April* 23, 1931.—A continuation of the work of Zeeman and Bakker on the same subject. The partial analysis of this spectrum by Kichlur is corrected, and it has proved possible, with the help of new wave-length measurements and of the Zeeman effects, to identify various new terms. Tables are given containing the theoretical term scheme; the lower terms of the spectrum with the g values; the Zeeman effects of 90 lines, including the Zeeman effect calculated by the Landé g formula, the observed effect, and that calculated with the help of the anomalous g values, the observed values of which are also tabulated. The application of the g summation law is considered. H. N. A.

3105. Quadratic Stark Effect. K. F. Herzfeld. *Zeits. f. Physik*, 69. 3–4. *pp.* 249–252, *May* 1, 1931.—A theoretical discussion of the difference in behaviour of a rigid rotator with horizontal axis and a harmonic oscillator in a vertical field. It is shown that for linear motion the restoring force will be proportional to the fifth power of the displacement. F. S.

3106. Activation of Matter by Resistance Cells. G. Reboul. *Comptes Rendus*, 192. *pp.* 926–928, *April* 20, 1931.—The activation previously described [see Abstract 3747 (1930)] is traced to articles of furniture on which radioactive dust had been deposited accidentally, in the course of other experiments. Experiments carried out after removal of these articles show that certain substances, especially paper or cardboard, after exposure to radiation from the cells blacken a photographic plate protected by black paper; and also that a metallic plate similarly exposed is not in electric equilibrium, and only returns thereto slowly. The effect is as though the plate were at first charged positively and then negatively. It is suggested that this is due to escape of electrons by reason of reduction in the potential gradient at the surface. C. A. S.

3107. X-Ray Studies of the Structure of Hair, Wool and Related Fibres. W. T. Astbury and A. Street. *Roy. Soc., Phil. Trans.* 230. *pp.* 75–101, *March* 13, 1931.—The results of X-ray analysis of wool and other animal fibres, including Geelong 80's merino wool, Australian 64's merino wool, English Cotswold wool, human hair, llama hair, hedgehog spines, and porcupine quills. Apparently all animal hairs give substantially the same X-ray photograph. A photograph of unstretched hair is referred to as typical, and is provisionally characterised as a rectangular cell of dimensions, $a = 27$ Å, $b = 10{\cdot}3$ Å, and $c = 9{\cdot}8$ Å. This α type disappears on stretching and is replaced by a β type which first becomes prominent at 30 % extension. The dimensions of the rectangular cell of the β type are provisionally given as $a = 9{\cdot}3$ Å., $b = 6{\cdot}64$ Å., and $c = 9{\cdot}8$ Å. The transformation from the α to the β type is reversible, and gives a qualitative and quantitative explanation of tensile characteristics of hair. From a preliminary examination, the structure of cystine is shown to have a hexagonal lattice, with three molecules per cell, and $a = 9{\cdot}40$ Å. and $c = 9{\cdot}42$ Å. The structure of cystine and the action of sodium sulphide on the *B* form suggest that the latter is based on molecular chains linked side by side by nuclei of cystine or cysteine. The chief molecular grouping of the form repeats along the fibre axis with a period equal to the most prominent period of cellulose (5·15 Å.). The X-ray measurements suggest that the primary molecular grouping of hair keratin is based on equimolecular proportions of the four chief constituent amino-acids, leucine, glutamic acid, cysteine and arginine. An addendum to the paper describes preliminary experiments on the action of steam on the elastic properties of animal fibres. S. G. B.

3108. Interference Measurements in Single Molecules. L. Bewilogua. *Phys. Zeits*, 32. *pp.* 265–282, *April* 1, 1931.—Gives detailed data, with tables and curves, for $CHCl_3$, CH_2Cl_2, CH_3Cl, and CCl_4. Of these, the last is a regular tetrahedron. [See also Abstract 1933 (1931).] A. D.

3109. X-Ray Diffraction by Incandescent Carbon. M. Hirata. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 299. *pp.* 219–226, *May* 1, 1931. *In English.*—X-ray diffraction photographs of the incandes-

cent positive and negative poles of a carbon arc have been taken. The thermal expansion of graphite takes place only in the direction perpendicular to the most closely packed plane (002). Calculating the temperature of the graphite from its brightness the coefficient of expansion is found to be approximately 40×10^{-6}, which is much larger than the value found at ordinary temperatures. Some amorphous scattering was observed at the positive pole. While the origin of this scattering is unknown, it is unlikely that it is to be attributed to molten carbon. F. J. W.

3110. Interaction of X-Rays with Bound Electrons. A. J. O'Leary. *Phys. Rev.* 37. *pp.* 873–883, *April* 15, 1931.—An analysis, by means of the double crystal spectrometer, of characteristic molybdenum K_α, X-rays scattered by carbon and berylium, has failed to show the existence of fine structure lines due to an absorption of an amount of energy equal to the binding energy of the electron in the scattering substance. The author suggests two different explanations. E. E. F. d'A.

3111. Compton Effect. S. Kikuchi. *Zeits. f. Physik*, 68. 11–12. *pp.* 803–812, *April* 20, 1931.—The Compton effect is investigated quantum-electrodynamically, and it is shown that Compton's original conception of the collision of two elastic particles is still valid, for the single process, within the indeterminacy relation. C. B. A.

3112. Scattering of X-Rays in Argon. G. Herzog. *Zeits. f. Physik*, 69. 3–4. *pp.* 207–234, *May* 1, 1931. *Helv. Phys. Acta*, 4. 3–4. *pp.* 139–142, 1931.—The angular distribution of X-rays scattered in argon is measured photographically. The measurements confirm the intensities calculated on wave-mechanical theory by Waller and Hartree, and also the corresponding atom model. A paper by A. H. Compton [see Abstract 3164 (1930)] is discussed. The limits to the possibility of deducing the electric distribution in the scattering atom from the measured scattering intensities are investigated. C. B. A.

3113. Diffuse Scattering of X-Rays by Solids. G. E. M. Jauncey. *Phys. Rev.* 37. *pp.* 1193–1202, *May* 15, 1931.—The classical theory of X-ray scattering has been applied to the scattering of X-rays by the electrons in the atoms of a solid. The case in which the solid consists of atoms of one kind has been considered. The interactions of the waves scattered by each electron with those scattered by every other electron in the solid have been considered. The analysis is simplified by the fact that the orbital periods of the electrons in the atoms are very much shorter than the vibrational periods of the atoms due to thermal agitations. The final formula obtained is $S = 1 + (Z - 1)f'^2/Z^2 + F^2X/ZN$, where S is the scattered intensity per electron relative to the scattered intensity from a single isolated electron, Z is the atomic number, F the atomic structure factor including the effect of thermal agitation, f' is related to f the true atomic structure factor (without thermal agitation), N is the total number of atoms, and X is a certain double summation. The value of X has not been obtained for an amorphous substance, but it has been evaluated for the case of a simple cubic crystal by Jauncey and Harvey [see following Abstract]. AUTHOR.

3114. Diffuse Scattering of X-Rays by Simple Cubic Crystals. G. E. M. Jauncey and G. G. Harvey. *Phys. Rev.* 37. *pp.* 1203–1209, *May* 15, 1931.—The value of X [see preceding Abstract] has been deter-

mined for the case of a simple cubic crystal consisting of atoms of one kind, and the formula obtained by Jauncey reduces to $S = 1 + (Z - 1)f'^2_1 Z^2 - F^2/Z$. There are no experimental results for a crystal consisting of atoms of one kind, but Jauncey and May have obtained values for the diffuse scattering of X-rays from a crystal of rock-salt. Assuming rock-salt to consist of atoms of atomic number (11 + 17)/2 or 14, the authors calculated values of f', using values of F given by James and Firth. These calculated values of f' are found to be only slightly greater than the values of F at absolute zero. Also Jauncey has measured the effect of temperature on the diffuse scattering from crystals. From the above formula calculations of the ratio of the scattering at temperatures of 568° and 290° K. have been made, using F values given by James and Firth. The theoretical and experimental values of this ratio in one case are 1·29 and 1·33 respectively, and in another case are 1·13 and 1·18, thus showing good agreement between theory and experiment. AUTHORS.

3115. Pantograph for Enlarging X-Ray Photographs. C. J. Ksanda. *Rev. Sci. Instruments*, 2. *pp.* 305-306, *May*, 1931.—The feature of the parallelogram pantograph described is that by using it all the advantages inherent in Bernal's chart and tables for structural determinations are retained. The apparatus is well suited to rotation, oscillation, or Laue methods, and the enlargement is made rapidly and with the maximum degree of elimination of personal errors in transfer. Adjustments on the pantograph allow of the ratio being quickly changed when desired. F. I. G. R.

3116. Ultra Soft X-Rays. V. Dolejšek. *Comptes Rendus*, 192. *pp.* 1088–1089, *May* 4, 1931.—Uses Osgood's method with a ferro-chromium gas tube, 1000 volts and 10 to 200 mA. Kathode and antikathode are made of the same material. Obtains a series of lines, of which the strongest is a doublet of about 480 Å., probably due to Mg. E. E. F. d'A.

3117. Reflection and Absorption of Soft X-Rays. M. Schein. *Helv. Phys. Acta*, 4. 3–4. *pp.* 149–152, 1931. *In German. Paper read before the Schweiz. Phys. Gesell., Zurich, May* 2, 1931.—The object of the investigation was to determine the refractive index of quartz for X-rays of great wave-length by the total reflection method. Some of the experimental work was done by **E. Dershem** in Chicago. The author concludes that there is a very great probability that the refractive index of quartz for the K_α line of carbon 44·6 Å. is $n = 1 - 4{\cdot}8 \times 10^{-3}$. H. N. A.

3118. Intense X-Ray Spectra Obtained with Concave Crystals. H. H. Johann. *Zeits. f. Physik*, 69. 3–4. *pp.* 185-206, *May* 1, 1931.—It is shown geometrically and by calculation that sharp intense spectra can be produced by Bragg reflection of X-rays from the concave side of a thin flexible crystal, such as mica, bent into a cylindrical form. No slit is required. The special sources of error inherent in the method are discussed, and the intensity obtained is compared with that of other methods. A spectroscope constructed according to these principles is described, and some spectra photographed with it are reproduced. The method is less suitable for absolute than for relative measurements, and should be very valuable where it is not easy to give long exposures, and for the discovery of faint lines and photographing absorption spectra; also for spectroscopic analysis. H. N. A.

3119. Structure of X-Ray Absorption Edges of Light Elements by Means of the Electron Tube Counter. H. Neufeldt. *Zeits. f. Physik*, 68. 9–10. *pp.* 659–674, *April* 13, 1931.—By the use of an electron tube counter it is possible to carry out spectroscopic absorption measurements with considerable accuracy in the long wave-length X-ray region from 15 to 50 Å. Sharply defined fine structure is found in the edges for O, N, C and Cr. This is attributed to double electron transitions. The fine structure is measured accurately, and is set out graphically and in tables. C. B. A.

3120. X-Ray Non-Diagram Lines. G. B. Deodhar. *Roy. Soc., Proc.* 131. *pp.* 476–493, *May* 1, 1931.—In the present paper it has been shown that in the K and L series non-diagram lines, pairs are found which show approximately constant $\sqrt{\nu/R}$ differences. These seem to resemble the usual screening doublets in the X-ray absorption spectra. It seems that the components of such pairs arise from transitions in multiply-ionised atoms characterised by the same initial and final total quantum numbers, but different screening constants. In spite of the more or less constant $\Delta\sqrt{\nu/R}$ values all the pairs do not show the required linear variation of $\Delta\nu/R$ with atomic number. In this matter also these pairs appear to have analogy with the usual screening doublets. It has been shown that behaviour of the β_3, η and β^{III} lines in the K series becomes more regular when they are associated with the K_{α_1} instead of the K_{β_1} line. It is demonstrated that the β_3 line probably arises from the double jump $M_1 \rightarrow L_{III}$ and $L_{III} \rightarrow K$. Author.

3121. Absorption of the K_α Line of Carbon in Various Gases and its Dependence upon Atomic Number. E. Dershem and M. Schein. *Phys. Rev.* 37. *pp* 1238–1245, *May* 15, 1931.—A description is given of the apparatus and methods used in a photographic investigation of absorption coefficients for the K*a* line of the carbon ($\lambda = 44{\cdot}6$ Å.) in different gases and in gold leaf. The mass absorption coefficients, μ/ρ, found were as follows: He, 3600; CO_2, 4780; N_2, 3850; O_2, 5765; Ne, 13,100; A, 45,700; Kr, 31,800; Xe, 6740; Au, 12,500. Some of the atomic absorption coefficients (μ_a) derived from these values on the assumption that the absorption is independent of chemical combination are as follows: C, $0{\cdot}44 \times 10^{-19}$; N, $0{\cdot}89 \times 10^{-19}$; O, $1{\cdot}52 \times 10^{-19}$; Ne, $4{\cdot}36 \times 10^{-19}$. The wave-length of the K_α line of carbon lies between the K and L_1 absorption limits of these elements. The values of $\log \mu_a$ when plotted against $\log Z$ fall upon a straight line whose slope is 4·4. Hence in this wave-length region this should be the value of p in the equation $\tau_a = C\lambda^n Z^p$, provided that $\lambda_K < \lambda < \lambda_L$. The results of extrapolating current X-ray formulæ to this wave-length are given and the values of μ_a so obtained are, in general, considerably too large. Since the exponent of Z in the above equation is found experimentally to be as large as or larger than in the case of ordinary X-rays it appears that the proper exponent of λ may be considerably less than 3. Authors.

3122. Reflection of the Kα Line of Carbon from Quartz and its Relation to Index of Refraction and Absorption Coefficient. E. Dershem and M. Schein. *Phys. Rev.* 37. *pp.* 1246–1251, *May* 15, 1931.—Measurements were made of the ratio of the intensity of the reflected ray to that of the incident ray in the case of the K*a* line of carbon reflected from a mirror of fused quartz for glancing angles of incidence between

1° 30′ and 8°. The atomic absorption coefficients of C, N, O and Ne were experimentally determined by the writers [see preceding Abstract]. This gave the value of the oxygen coefficients directly and data from which the atomic absorption coefficient of silicon could be calculated. The linear absorption coefficient, μ, of quartz was then computed from its density, percentage composition, and the atomic absorption coefficients of its constituents. Then from the relation $\kappa = \mu\lambda/4\pi$, the absorption index κ was found to be $1{\cdot}68 \times 10^{-3}$. The value of $\delta = 1 - n$ was computed from the Drude-Lorentz formula and found to be $4{\cdot}8 \times 10^{-3}$. Convenient methods for the calculation of the intensity of either the parallel or perpendicular components of the reflected ray are derived from the Fresnel equations relating to absorbing media. A curve computed with the above values of δ and κ predicts somewhat higher reflectivity than found experimentally. Use of the value $\kappa = 2{\cdot}5 \times 10^{-3}$ yields a computed curve agreeing well with the experimental one. On the other hand, assuming values of δ other than that given above leads to less satisfactory agreement. AUTHORS.

3123. Elimination of the β Wave-length from the Characteristic Radiation of Iron. W. A. Wood. *Phys. Soc., Proc.* 43. *pp.* 275–278; *Disc.*, 278, *May* 1, 1931.—A practical method of eliminating the β wave-length from the characteristic H-radiation of iron is described. The method is based upon the selective absorption produced by a thin film of pure manganese which is obtained in the required form by electrodeposition upon aluminium foil. AUTHOR.

3124. X-Ray Search for Element 61. S. Takvorian. *Comptes Rendus*, 192. *pp.* 1220–1223, *May* 18, 1931.—A mixture of cerium ores extracted from monazite sands and rich in neodymium and samarium was treated by fractional crystallisation of the double magnesium nitrates, intermediate fractions of double neodymium-samarium nitrates being collected. After further fractionation, the last fractions were submitted to careful X-ray analysis for the element 61. The photometric records of the X-ray absorption spectra (sensitivity 2 %) show no discontinuity between the K-edges of Nd (60) and Sm (62). The emission spectra were found to be stronger for the L-series than for the K-series, in contrast to previous observations. In no fraction was any L-line attributable to the element 61 observed, although those of Nd and Sm were well developed. The 61 lines were also absent from the weaker K-spectra. The sensitivity of the emission spectrum method indicates that these fractions, representing 1/200 of the initial material, cannot contain a quantity of element 61 exceeding 1/10,000. C. B. A.

RADIOACTIVITY.

3125. Radioactive Investigations on a Salt-Dome at Sperenberg. F. Breyer. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 1–4. *pp.* 373–419, 1931.—The apparatus used consists of a small collector hung at varying depths in a vertical hole 2 m. deep, connected with an electrometer placed vertically over the hole, with or without arrangements to close the hole. The amounts of emanation thus detected at varying depths plotted against the depth give a hyperbolic curve with horizontal and vertical asymptotes indicating respectively (relatively) zero emanation at the surface and an amount that becomes practically constant at about 50 cm. depth. Meteorological and surface conditions cause greater variations than deeper geological causes. Still a series of such curves obtained from holes along horizontal surface lines perpendicular to what was supposed to be the boundary of a salt-dome at Sperenberg some 50–100 m. below the surface, indicated a series of maxima vertically above where that boundary might be expected to lie. Specially low figures occurred where the surface soil was specially porous. Numerous details regarding the method and its possible improvement are given. C. A. S.

3126. Luminescence Due to Radioactivity. D. H. Kabakjian. *Phys. Rev.* 37. *pp.* 1120–1128, *May* 1, 1931.—A review of results obtained by the author shows that the explanation of the process cannot be that of Rutherford. In certain substances there is an initial rise of brightness followed by a non-exponential decay. The observed facts can be explained by assuming that the rays produce excited molecules. The rays affect the absorption, and the apparent decay of brightness is due to this rather than to destruction of centres. Heating the samples restores the initial brightness. No quantitative application of these suggestions is attempted. J. E.

3127. Decay Constant of Uranium II. C. H. Collie. *Roy. Soc., Proc.* 131. *pp.* 541–553, *June* 3, 1931.—The uranium X from a large quantity (10–15 kg.) of uranium nitrate, as free as possible from ionium, was separated and obtained in solution with a little cerous nitrate; to this was added a small known amount of ordinary uranium, which, with the uranium II formed from the uranium X after the lapse of a suitable time, was deposited electrolytically on a removable kathode. The kathode was transferred to an ionisation chamber, the α-particles emitted in a given time counted, and those due to uranium II determined by difference. The half-life period of uranium thus determined is at least a million years. Full details are given. C. A. S.

3128. Valve Methods of Recording Single α-Particles in the Presence of Powerful Ionising Radiations. C. E. Wynn-Williams and F. A. B. Ward. *Roy. Soc., Proc.* 131. *pp.* 391–409, *May* 1, 1931.—Describes the methods employed recently [see Abstract 528 (1931)] by Rutherford and the authors in the analysis of the short range α-rays from radium C, thorium C and actinium C. The recording processes were speeded up as much as possible by a suitable arrangement of amplifying valves, connecting with a special oscillograph, so as to avoid the super-

position of the small deflections produced by the unwanted radiations responsible for disturbances. Details are given of the apparatus and necessary precautions. The voltage amplification for the whole system was about 7×10^5; this represents the ratio between the voltage across the oscillograph and the voltage surge at the first valve grid. For the charge amplification factor the order of 10^9 to 10^{11} is obtainable. It should now be possible to extend the application of the method to long-range α-particles and to artificial disintegration. H. N. A.

3129. Complexity of α-Radiation of Radioactinium. Irène Curie. *Comptes Rendus*, 192. *pp.* 1102–1104, *May* 4, 1931.—Measurements of the range of α-particles of radioactinium (a method of preparing a uniform layer of which is described) by means of the Wilson expansion chamber show that these fall in about equal amounts into two groups with ranges in air, at 760 m. and 15° C., of 4·68 and 4·48 cm. Absence of actinium-X from the radioactinium used was definitely proved, as also the impossibility of the particles of less range being due to retardation at the source. The result may therefore indicate either branching or a fine structure of the α-radiation. The energy difference of the two groups, $2{\cdot}8 \times 10^5$ electron-volts, is very near the energy of the quantum of the most penetrating γ-rays of both actinium-X and radioactinium. C. A. S.

3130. Recoil Phenomenon and Conservation of Momentum. F. Joliot. *Comptes Rendus*, 192. *pp.* 1105–1107, *May* 4, 1931.—The experiments of Akiyama [see Abstract 142 (1925)] on the direction of the recoil atoms of actinon and actinium-A have been repeated with an improved apparatus giving recoil tracks up to 7 mm. long. The complexities observed fall into three classes: (1) when the recoil track is inclined to that of the α-particle there is at least one other track from the origin—ascribed to the radioactive atoms occurring in groups [see Abstract 2508 (1929)]; (2) several small tracks branch out from the main one—ascribed to collisions of the recoil atoms with the light atoms of the gas present; (3) the recoil track changes its direction abruptly, this being accompanied by another similar track starting from the point of change, indicating, apparently, collision with a heavy atom, but of what kind is not clear. There are therefore no grounds for assuming the emission of γ-rays simultaneously with that of the recoil atom. C. A. S.

3131. Straggling Curves by the Scintillation Method for α-Rays of Polonium. G. Destriau. *J. de Physique et le Radium*, 2. *pp.* 148–158, *May*, 1931.—To test the theory of I. Curie [see Abstract 2530 (1925)] that the difference between straggling curves obtained by scintillation from those obtained by any other method is due to variation in the number of phosphorogenic centres, curves were obtained for polonium with screens prepared with no binding material, and containing 1/50,000, 1/15,000 and 1/5000 of copper, with crystals averaging 13 μ, and, for the 1/15,000 screen, also 20 and 36 μ. The number of phosphorogenic centres increases, though not proportionally, with the amount of copper. The curves approach those obtained by other methods more nearly as the content of copper increases, and/or the size of crystals diminishes. The absence of binding material probably tends in the same direction. A calculation based on I. Curie's theory gives closely similar curves. C. A. S.

HEAT.

3132. Thermal Conductivity of Tin at Low Temperature. W. J. de Haas, S. Ayoama and H. Bremmer. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 75–84, 1931. *Comm. No.* 214*a from the Phys. Lab., Leiden.*—The sample of tin (from Kahlbaum) was in the form of a rod, 9 cm. long and 1·8 mm. thick. The method of measurement was similar to that first used by Lees [see Abstract 1677 (1908)]. Measurements were made at temperatures ranging from 12° K. (solid hydrogen) to 90° K. (boiling point of oxygen). The true coefficient of thermal conductivity could not be given with accuracy, owing to the indefinite contacts at the extremities of the rod. Results are therefore given of the values of w, the thermal resistance of the rod. A curve exhibiting these comparative results shows an increase from 110 units at 12·5° K. to 470 at 97° K., with a point of inflection near 15° K. [See also following Abstract.] T. B.

3133. Conduction of Heat by Lead and Tin at Low Temperatures. W. J. de Haas and H. Bremmer. *K. Akad. Amsterdam, Proc* 34. 3. *pp.* 325–338, 1931. *Comm. No.* 214*d from the Phys. Lab., Leiden.*—A more detailed account of the method previously used [see preceding Abstract] is given in this paper. Values are again given in thermal resistances (w) of the rods used, and not in terms of coefficients of thermal conductivities. Corrections are made for losses of heat by radiation and convection. In the case of lead a very marked minimum is shown for w at about 9° K. It is doubtful whether this is due to the last traces of impurities or whether it also exists for the purest metal. A measurement made in a longitudinal magnetic field at 4·2° to 4·4° K. gives a decreased resistance. New measurements at very low temperatures are also made in a newly-cast rod of Kahlbaum tin. These show a steadily decreasing resistance from 2° to 8° K., and no point of inflection. In a magnetic field at a mean temperature of 5·66° K. the resistances are found proportional to the square of the magnetic field. T. B.

3134. Measurement of Heat Conduction in Gases. Part I. M. Trautz and A. Zündel. *Zeits. f. techn. Physik,* 12. 6. *pp.* 273–284, 1931.—The paper consists of (1) an introduction; (2) a classified list of methods employed in measuring gas conduction: this contains three "cooling" methods, eight variants of the "heated wire" method, four "plate" methods and two miscellaneous methods; (3) a discussion of the various methods, together with critical tables of results; (4) a bibliography of 204 references. J. H. A.

3135. Friction, Heat Conduction and Diffusion in Gaseous Mixtures. Part XIV. M. Trautz. *Ann. d. Physik,* 8. 7. *pp.* 797–804, *April* 1, 1931.—The dependence of the friction coefficient upon pressure is little investigated, and the present work treats the subject theoretically for all aspects of the case. The pressure coefficient of the friction constant is derived for ordinary pressures from the gas theory, and it is found that for low pressures and not an ideal gas the coefficient is an exact linear function of the pressure. For high pressures the formula derived is not strongly valid, and for H_2 up to 100 atmospheres it was found valid only between 30° and 70°. The generalisation for binary mixtures of two non-reactive gases is deduced, and, finally, the reduction to the case of $v = \infty$ is fully treated. S. G. B.

3136. Radiating Power of Oxidised Palladium. W. Zobel. *Ann. d. Physik*, 9. 5. *pp.* 519–536, *May* 20, 1931.—The experiments were carried out to throw fresh light on the effects described by Auer [see Abstract 564 (1926)]. The radiation from a palladium strip 20 μ thick and 20 mm. wide was measured between 200° and 600° C. with a thermopile at pressures down to 10^{-4} mm. The emission was found to vary not only with pressure, but also with time at a fixed pressure. The reflecting power was also measured. The parts played by changes in the absorbed gas layer, and by oxidation and reduction, which lead also to recrystallisation of the reduced metal, are considered. J. H. A.

3137. Irregularities in Operation of Thermostat Contacts. R. Heilbrun and E. Turowski. *Phys. Zeits.* 32. *pp.* 282–286, *April* 1, 1931.—In the operation of thermostat contacts depending on the expansion of bimetallic strip it is sometimes found that the contacts for considerable periods maintain themselves a small distance apart, sparks passing between the contacts, and a singing sound being emitted. This effect was investigated and a stroboscopic examination showed that the sparks occurred quite regularly, the frequency varying from about 200 to 600 per sec. An explanation is to be found in the electrostatic attraction between the contacts, which periodically close and then open again. By fitting a compensating plate above the upper contact and connecting this to the lower contact the critical " singing " conditions may be eliminated and normal operation of the contacts secured. A. W.

3138. Thermostat for the Temperature Range 50°–112° Absolute. E. Justi. *Ann. d. Physik*, 9. 5. *pp.* 570–578, *May* 20, 1931. *From the Reichsanstalt.*—The construction and manipulation of a thermostat are described in which by adsorption of hydrogen in carbon at 112° Abs. temperatures up to 50° Abs. may be acquired by desorption, employing boiling nitrogen at atmospheric pressures. H. H. Ho.

3139. Thermoregulator for Operating Adiabatic Calorimeters. H. Rieche and R. Grau. *Zeits. f. techn. Physik*, 12. 6. *pp.* 284–286, 1931.—The apparatus is designed to raise the temperature of the outer jacket of a calorimeter outfit at the same rate as the inner vessel, so as to eliminate heat loss from the latter. By inserting resistance thermometers in both vessels and connecting with fixed resistances and a battery in a Wheatstone bridge, a current may be made to flow whenever there is a temperature difference between the two vessels. This current flows through a mirror galvanometer. Light from an independent source is reflected at the galvanometer mirror and then passes through a glass neutral wedge to a photoelectric or selenium cell. Thus the intensity of the light falling on the cell varies with the temperature difference between the two vessels, and by permitting the cell to operate relays, the rate of heating of the outer vessel is automatically controlled to be equal to that of the inner. J. H. A.

3140. Temperature Measurement of Rarefied Gases. R. Risch. *Zeits. f. techn. Physik*, 12. 6. *pp.* 286–288, 1931.—The order of magnitude of the error in measuring the temperature of rarefied gas by thermocouples is calculated, and numerical examples are given. The problem in view is that of measuring the gas temperature while a discharge is passing. J. H. A.

3141. New Determination of the Fixed Points below 0° C. W. Heuse and J. Otto. *Ann. d. Physik*, 9. 4. *pp.* 486–504, *May* 7, 1931. *From the Reichsanstalt.*—The results obtained, on the thermodynamic scale, are set out below. They were measured on the helium gas-thermometer, and observations taken also by vapour-pressure thermometers (hydrogen) and by resistance thermometers.

Boiling point of hydrogen	— 252·780° C.
Boiling point of oxygen	— 182·962° C.
Sublimation point of CO_2	— 78·483° C.
Melting point of mercury	— 38·832° C.

The relation between the temperature scale in use at the Reichsanstalt and the thermodynamic scale is discussed. J. H. A.

3142. Arc Temperature. A. v. Engel and M. Steenbeck. *Wiss. Veröff. a. d. Siemens-Konzern*, 10. 2. *pp.* 155–171, 1931.—A comprehensive review of arc investigations precedes the description of a method of measuring the mean temperature of an arc in which a beam of X-rays is passed through the arc longitudinally and measured. The temperature is related to the density in the arc, and the density is measured by the absorption of the X-rays. The authors show that the non-uniformity of the arc path may be eliminated by taking two measurements with different arc lengths. A typical arc used is one of 2 amperes at 3000 volts, from a d.c. machine. Experiments with nitrogen gave an arc temperature in the positive column of 5460° ± 320° K., and with air, 5270° ± 300° K. Allowing for dissociation $N_2 \longleftrightarrow 2N$, the apparent temperatures are about 280° K. lower. A fine carbon rod placed in the arc gave a pyrometer temperature of 2300° K. for nitrogen and 3100° K. for air, the difference in temperature being solely due to chemical reaction. L. E. C. H.

3143. Atomic Heat of Crystalline Substances at Constant Pressure. Y. Endō. *Tokyo Univ. Aeronaut. Research Inst., Report No.* 71, *pp.* 71–82, *April*, 1931. *In English.*—A discussion of the variations of atomic heat with temperature, using classical quantum mechanics and treating the solid as a lattice. J. H. A.

3144. New Formulæ for Calculating Specific Heat, Expansion Coefficient and Vapour Pressure of Water. P. H. Hofbauer. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 353–363, *May* 17, 1931. *In German.*—The specific heat of liquid water at absolute temperature T is found empirically to be well represented by the formula $({}^{-1}e/{}^{-1}\gamma)^{3/2}$, where ${}^{-1}e = e^{1/e}$, ${}^{-1}\gamma = \gamma^{1/\gamma}$, e is the base of the natural logarithms and γ is $e\mathrm{T}/310$. The justification for taking T/310 is that 310° K. is the temperature at which the specific heat is a minimum. Similarly, a first approximation formula for the coefficient of cubic expansion of water is $({}^{-1}e/{}^{-1}q)^3$, where the "index" notation is as before, and q is $e\mathrm{T}/277$. Here 277° K. is the temperature of maximum density of water, whilst e and T have their earlier significance. The formula is improved by introducing a correcting factor, so that it reads $({}^{-1}e/{}^{-1}q')^3$, where $q' = q(1 + \mathrm{E}\Sigma)$. In this expression E is 4·241 and Σ is $e\{(\mathrm{T} - 277)/277\}(m - 1)$, where m is the mean specific heat between 277° and T° K. For the latent heat of evaporation of water, the first approximation is $\log \mathrm{P}/760 = k(\mathrm{T} - 373)\,(\mathrm{T}/373)^{-\epsilon}$, where $\epsilon = {}^{-2}e$, *i.e.*, $e^{1/e^2} = 1{\cdot}14492$. As in the case of the expansion coefficient, this may be improved by introducing a function of the mean specific heat (as given by the first formula). A formula for the latent heat of fusion of ice is also given. J. H. A.

3145. Calorimetric Determinations of Thermal Properties of Methyl Alcohol, Ethyl Alcohol and Benzene. E. F. Fiock, D. C. Ginnings and W. B. Holton. *Bureau of Standards, J. of Research*, 6. *pp.* 881-900, *May*, 1931.—The method and calorimetric equipment previously used [see Abstract 2368B (1930)] in the determination of thermal properties of saturated water and steam were applied, without essential modification, in an investigation of corresponding properties of methyl alcohol, ethyl alcohol and benzene. Precautions were taken to obtain these liquids in a very pure state. Determinations were made in the range from 40° to 110° C., yielding values of latent heats of vaporisation and changes in heat content. Empirical equations fitted to these properties aid in the interpolation, extrapolation and application of the data. An estimate is made of the precision of the final results. A skeleton table of the more commonly used thermal properties of the saturated liquids and vapours has been prepared. Comparisons with the values of previous investigators are included. AUTHORS.

3146. Most Probable Values of C_v for Water Vapour, Ammonia, Methane and Higher Paraffins. M. Trautz. *Ann. d. Physik*, 9. 4. *pp.* 465–485, *May* 7, 1931.—A general formula, based partly on empirical relations previously announced by the author, is derived for the specific heat at constant volume of the gases mentioned. The constants in it are deduced by correlating the available observations. J. H. A.

3147. Variation of Specific Heats (C_p) of Oxygen, Nitrogen and Hydrogen with Pressure. E. J. Workman. *Phys. Rev.* 37. *pp.* 1345–1355, *May* 15, 1931.—The specific heats C_p of oxygen at 26° and 60° C., nitrogen at 26° and 60° C. and hydrogen at 50° C. have been measured as a function of pressure over the pressure range 10 to 130 kg./cm.^{2}. A continuous flow method is used by which the ratio of C_p at a pressure p to $(C_p)_0$ of the same gas at a pressure of 1 atmosphere is measured. The theory of the method shows that the experimental results are practically independent of the usual errors arising from heat leakage and the Joule-Thomson effect. Complete experimental curves as well as tabulated values are shown for $C_p/(C_p)_0$ as a function of pressure. Details of construction and use of the apparatus are given. AUTHOR.

3148. Calculation of Vapour Pressures of Solid Bodies from their Solubilities. L. Frank. *Zeits. f. Physik*, 69. 5–6. *pp.* 418–420, *May* 12, 1931.—An indirect method for calculating small vapour pressures, and so affording a control criterion for direct experimental measurements, is now proposed by means of a formula which expresses the partial pressure as a function of the composition. Data are given for various mixtures of organic substances. H. H. Ho.

3149. Sama Condition. Part III (2). E. A. Holm. *Arkiv. f. Mat., Astron., och Fysik, Stockholm*, 22A. 3. *pp.* 1–65, 1931. *In German.* —Continues previous work [Part III (1), see Abstract 709 (1930)], and deals with experiments on the vapour of dimethylacetone xylose and a solution of 80 % of this substance and 20 % of monomethylacetone xylose. Experimental technique, observed data, absolute values, effect of impurities, corrections and results are in turn discussed. H. H. Ho.

3150. Compressibility Isotherms of Helium at Temperatures from − 70° to 200° C. and at Pressures to 1000 Atmospheres. R. Wiebe, V. L. Gaddy and C. Heins, Jr. *Am. Chem. Soc., J.* 53. *pp.* 1721–1727, *May*, 1931.—The method employed and apparatus used are briefly

referred to, and very comprehensive data recorded for the compressibility isotherms of helium at $-70°$, $-35°$, 0°, 50°, 100° and 200° C. up to 1000 atmospheres pressure. The knowledge of the compressibility of a gas which is chemically inactive and only slightly adsorbed by most catalysts will aid greatly in the determination of the adsorption of various gases on catalysts at high pressures, whilst it will also be of value in the theoretical study of gases under high pressures. H. H. Ho.

3151. Entropy and Free Energy of Methane. H. H. Storch. *Am. Chem. Soc., J.* 53. *pp.* 1266–1269, *April*, 1931.—The entropy of methane at 25° as calculated from Clusius' recent low-temperature specific heat measurements [see Abstract 2786 (1929)] is 43·39 units. By calculation from equilibrium measurements for the reactions $CO_2 + 4H_2 = CH_4 + 2H_2O$ and $C + 2H_2 = CH_4$, using Eastman's revision of the specific heat equations of C, H_2, H_2O and CO_2, the measurements of Eucken and Lüde of the specific heat of methane in the range 297·7°–481·2° K. and an experimental value (recently determined by the U.S. Bureau of Standards) of the heat of combustion of methane, the figures 42·16 and 45·24 entropy units, respectively, were obtained. The value 43·39 entropy units as calculated from specific heat measurements is close to the average of the two data calculated from equilibrium measurements and is considered to be the most reliable estimate available at present. A free energy equation for methane based on this entropy figure is presented. H. H. Ho.

3152. Point of Zero Entropy of Solids from the Standpoint of Quantum Statistics. Parts I, II and III. H. Ludloff. *Zeits. f. Physik*, 68. 7–8. *pp.* 433–492, *April* 7, 1931.—In Part I, Eucken's results relating to the entropy of solids at low temperatures are critically examined and compared with results to be anticipated from the quantum theory, which indicates that the entropy is not nil at the absolute zero of temperature. In Part II the author deduces formulæ for the entropy of solids and the partition law in accordance with Fermi's statistical theory, whilst in Part III the question of the multiplicity of lowest energy states is discussed and exemplified. J. S. G. T.

3153. General Equations of Energy and Entropy of Gases. T. C. Huang. *Phys. Rev.* 37. *pp.* 1171–1174, *May* 1, 1931.—By substituting the general equation of state for any gas, $p = T\Psi(v) - \Phi(v) - F(v, T)$, in the thermodynamic equation $Tds = du + pdv$, and by applying the principle of exact differential, the following general equations of energy and entropy have been obtained: $u = \int\Phi(v)dv + \int[F - T\partial F/\partial T]dv + \alpha(T)$; $s = \int\Psi(v)dv - \int\partial F/\partial T dv + \beta(T)$. The values of $\alpha(T)$ and $\beta(T)$, both arbitrary functions of temperature, are found to be $\alpha(T) = \int c_{v_\infty} dT + k_1$; $\beta(T) = \int\alpha'(T) \cdot T^{-1} \cdot dT + \text{const.} = \int c_{v_\infty} \cdot T^{-1} \cdot dT + k_2$, where c_{v_∞} = heat capacity of the gas at constant volume and at infinite dilution. The equations are applied to a perfect gas as well as to gases obeying van der Waals', Clausius' and Dieterici's equation of state and are found to give results in agreement with those obtained from other thermodynamic equations. Author.

3154. Thermodynamic Studies. A. Press. *Zeits. f. Physik*, 69. 7–8. *pp.* 483–494, *May* 28, 1931.—The equation of state for a simple body is developed in series form from the simplest available assumptions. A wider conception of entropy is introduced, and its applications are illustrated. J. H. A.

SOUND.

3155. Theory of Melde's Experiment. R. Serini. *Accad. Lincei, Atti,* 13. *pp.* 62–66, *Jan.* 4, 1931.—A mathematical investigation of the motion of a string with one end attached to a tuning-fork.

E. E. F. d'A.

3156. Optimum Time of Reverberation of Auditoriums. G. v. Békésy. *Ann. d. Physik,* 8. 7. *pp.* 851–873, *April* 1, 1931.—An observer can be conscious, at any time, of only a small region of the field of hearing, named the effective space. For the latter it is convenient to substitute the corresponding "effective time." When the reverberation due to a source of sound which has been suddenly stopped lasts longer than the effective time, it can be perceived as something distinct from the original sound. It is necessary for good acoustics that the period of reverberation should be equal to the effective time for sounds of medium loudness. The mean effective time was determined under various conditions, and when substituted in the well-known expression for the period of reverberation, gave the most favourable time of reverberation in terms of the size of the auditorium. G. E. A.

3157. Acoustics of Music Rooms. V. O. Knudsen. *Acoustical Soc. of America, J.* 2. *pp.* 434–467, *April,* 1931.—The author states that as a result of study of various famous European music rooms or concert halls he has been led to consider the problem of music-room acoustics in the light of recent developments in acoustics and the tested results of experience, and to call attention to certain problems which require further investigation. Some of the more famous concert halls are considered in detail, and in conclusion a chart is given showing the optimal reverberation times for rooms of various sizes and various types of music. He suggests that it would be a valuable feature to be able to vary the reverberation time of a room to suit the type of music being played. This could readily be done by shutters in the ceiling with an absorptive material behind them. F. S. B.

3158. Sound Rays as Extremals. H. Bateman. *Acoustical Soc. of America, J.* 2. *pp.* 468–475, *April,* 1931.—A mathematical paper, unsuitable for abstracting, in which are developed equations representing a general form of Doppler's principle applicable when the source of sound and the receiver are both in motion and the wind velocity is different in different places. F. S. B.

3159. Sound Transmission Coefficients and Reduction Factors. P. E. Sabine. *Acoustical Soc. of America, J.* 2. *pp.* 506–513, *April,* 1931. —Wide differences exist in measurements by different observers of the sound transmission through walls and partitions of essentially the same structure, and in a recent paper Knudsen has attempted to reconcile these, and has further suggested the use of a new unit "transmission loss" expressed in decibels and defined by the equation T.L. $= 10 \log J_I/J_T$, where J_I is the sound energy flux (ergs/sq. m./sec.) incident upon one face of the partition, and J_T the sound energy flux away from the partition on the opposite side. In the present paper the author discusses at some length these attempts at reconciliation, and gives the following conclusions:

(1) That in measuring the sound insulating properties of walls the choice of test tones has an important bearing on the absolute value of the average figure obtained as a numerical measure of the insulating properties of partitions. Standard practice in this respect is desirable. (2) That the difference in the definition of the term "reduction factor" as measured at the Bureau of Standards and the author's Riverbank laboratories is not the explanation of the difference of results obtained. (3) That the conditions of test in the author's laboratory give average values in reductions of the order of 1 or 2 db lower than the transmission loss as defined by Knudsen. (4) That the effect of reverberation in the receiving room is in the same direction and of the same order of magnitude as indicated by Buckingham's analysis. (5) That the average reduction afforded by a given reduction over the whole range of frequencies is, within the range of experiments cited, independent of the area of the test panel, provided the ratio of the absorbing power in the test room to the cross-section of the transmitting panel is the same in the two cases. F. S. B.

3160. Noise. K. W. Wagner. *Preuss. Akad. Wiss. Berlin, Ber.* 9. *pp.* 154–165, 1931.—The effects of noise are numerous. Loud continuous noise produces deafness, *e.g.*, among metal workers. Noise has been observed to affect the working of the brain-mass and the heart, to increase the blood pressure, and to cause irregular contraction of the stomach. It lowers the efficiency of manual and mental activity. The abatement of noise has been taken up by a commission in New York, and by a Committee of the Society of German engineers. The loudness of a noise N_1 is measured in terms of a standard sound N_2 by $L = 10 \log (N_1/N_2)$, where N_1 and N_2 refer to the densities of the respective sound radiations, and L is expressed in "phons." In New York, street noises varied from 45 to 80 phons. In considering house noises more particularly, sounds which pass through a wall are conveyed chiefly by a membrane-like vibration of the wall. The transmitting power of the wall is calculated, and the result agrees with the value found by measuring the sound intensities before and after passing through the wall. The amplitude of vibration of the wall, of brick 9 cm. thick, was about 6×10^{-8} cm. [See also following Abstract.] G. E. A.

3161. Sound Insulation by Simple Partition Walls. E. Meyer. *Preuss. Akad. Wiss. Berlin, Ber.* 9. *pp.* 166–181, 1931.—The sound insulating power of simple walls 2 m. square was investigated by an electro-acoustical method. The weight of the wall varied from 2 to 500 kg./m.^{2}, and the results show that the insulating power is related in a linear manner to the logarithm of the weight of the wall. The insulating power is defined as the logarithm of the ratio of the sound energy incident on the wall to the energy which the wall transmits, and the paper describes how these quantities are determined. A h.f. electrical method is employed to measure the vibrations of the wall. Working with a 9 cm. thick brick wall polished on both sides, an incident pressure amplitude of 10 dyne/cm.^{2} produced in the wall vibrations of amplitude 1000 Å. at frequency 100, and 1 Å. at frequency 4000. The insulating power of the wall as calculated from the speed amplitude agrees with that found by experiment. The fundamental frequencies of nine walls tested had values from 7 to 51. [See also preceding Abstract.] G. E. A.

3162. Sound Insulation in Skyscrapers. E. Meyer. *V.D.I.* 75. *pp.* 563–566, *May* 2, 1931.—Summarises the various kinds of sound

transmission, and the methods of dealing with them. The chief mode of propagation is not through the air, but by transverse or longitudinal solid waves, chiefly the former. The stoppage of sound by walls is practically proportional to their weight, irrespective of the material employed. For tall steel structures it is of great importance to have substances of good "resistance" to sound waves, such resistance being defined as the product of the density and the velocity of sound in the substance. For air, it is 43, for sandstone 5300, for iron 40,000 c.g.s. units. When a sound wave passes from one medium to another, the diminution is in accordance with the difference of resistance of the two media. From sandstone to air the wave is reduced about 1000 times (*i.e.*, by 30 "phons"). E. E. F. d'A.

3163. Acoustical Investigations of Musical Instruments. Part IV. The Koto, a Thirteen-Stringed Instrument. J. Obata and E. Sugita. *Phys. Math. Soc., Japan, Proc.* 13. *pp.* 133–150, *May*, 1931. *In English.*—The tone-colour of the koto, a thirteen-stringed instrument, was investigated by means of the same method as in previous work [see Abstract 2750 (1931)]. In the tone of the koto the amplitude of the sound pressure is, in the majority of cases, not greatest at the beginning but reaches a maximum after the lapse of a certain time, probably due to the influence of the large wooden body. Moreover, owing to the large body, its resonance as well as that of the other strings is remarkable, and when superposed on the tone of the struck string constitutes its characteristic tone-colour. The tone of the koto contains, besides the fundamentals, partials of comparatively low order, this being the main difference in its tone-colour from that of the syamisen. In the tone of the lower register the third, or sometimes the fourth, harmonics are the most prominent, while in the tone of the middle register the fundamental and the second harmonics are the strongest, and, finally, the tones of the higher register are comparatively pure, consisting mainly of the fundamental. Differences of the tone-colour of different instruments, of different methods of playing, of the same instrument in cases tuned in different absolute pitch, etc., were studied. Finally, the differences of the tuning of different players were determined. AUTHORS.

3164. Speed of Sound in Solids and Liquids. Part II. O. Stierstadt. *Phys. Zeits.* 32. *pp.* 346–348, *April* 15, 1931.—In a previous paper [see Abstract 2371 (1931)] it was found that the speed of sound in a solid substance was twice that in the liquid. This result is examined from the theoretical side. If the modulus of elasticity is expressed as a function of the energy content, equations can be derived from which, in conjunction with the measurement of the speed of sound, the ratio of the specific heats above and below the melting point can be calculated. It also follows that the elasticities in the solid and liquid states are in the ratio 4 : 1. G. E. A.

3165. Velocity of Sound-Waves in a Tube. G. G. Sherratt and J. H. Awbery. *Phys. Soc., Proc.* 43. *pp.* 242–251; *Disc.*, 251–253, *May* 1, 1931.—The apparent velocity of sound in a tube of diameter 2 cm. has been measured at temperatures up to 400° C. and with frequencies of from 3000 to 14,000 $\sim$. The reduction in velocity below the free-air value is discussed, and the suggestion is put forward that this reduction, for a single tube and gas, depends on the wave-length rather than on the frequency. The theoretical expression found by Helmholtz

and Kirchhoff for the reduction in velocity does not appear to be valid, at any rate for the conditions obtaining in these experiments. The method used by Dixon [see Abstract 605 (1922)] and by Partington and Shilling for correcting for the influence of the tube receives support from the present results. The experiments reveal the complication which ensues when the wave-length falls below a certain multiple of the tube diameter. AUTHORS.

3166. Tube Effect in Sound-Velocity Measurements. P. S. H. Henry. *Phys. Soc., Proc.* 43. *pp.* 340–361; *Disc.*, 362, *May* 1, 1931.—The modifications of Kirchhoff's formula required to take account of the finite thermal conductivity of the tube, slip between the gas and the walls, temperature-discontinuity between the gas and the walls, and absorption of energy by the walls are calculated and are found to be negligible. The effect of roughness of the walls is discussed, and the conclusion is drawn that the large tube-effects often found in practice are due to irregular motion of the gas. It is argued that the methods of correcting for the tube-effect used hitherto are unreliable. The effects of oscillation of the piston and of the gas behind the piston are investigated and it is shown that these may become appreciable in some forms of apparatus. The yielding of a tube of elliptical cross-section is calculated and is shown to have a negligible effect. AUTHOR.

3167. Effect of Distance from the Source on the Velocity of Sound at Ultrasonic Frequencies. C. D. Reid. *Phys. Rev.* 37. *pp.* 1147–1148, *May* 1, 1931.—Measurements of the velocity of ultrasonic waves have been made at a greater distance than heretofore. It is found to be independent of frequency within 0·01 %, which is the error of measurement. [See Abstract 2881 (1930).] AUTHOR.

3168. Supersonic Sound Waves. H. Straubel. *Phys. Zeits.* 32. *pp.* 379–381, *May* 1, 1931.—Hehlgans and Grossmann have shown that sound waves sent out from the end face of a quartz crystal rod oscillator have an asymmetrical distribution when the rod axes are respectively the optical axis of the crystal, an electrical axis, and a direction at right-angles to these two. With this cut, the nodal line is inclined to the edges of the rod, but by suitable orientation of the cut, the nodal line may be at right-angles to the edges. The crystals used in the research here described were cut in this way; they had a frequency of 75,000 p.p.s., corresponding to a wave-length in air of 4·4 mm. Using a single crystal placed on a polished slab of insulating material on which was scattered fine well-dried powder, pictures of the sound waves were obtained under various conditions. On passing through a slit, circular waves were obtained. One photograph shows the waves reflected from a concave mirror. With two oscillators of almost identical frequency arranged in line a small distance apart, a system of stationary waves was obtained, and with the two oscillators side by side, interesting interference effects were obtained. The directional effect with the two oscillators side by side and close together was found to be greater than with a single oscillator. As the distance between the oscillators was increased, the effects obtained were analogous to the maxima and minima obtained with a double slit illuminated by the same light source. A. W.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

3169. Contact Potentials. Part III. R. Fürth. *Zeits. f. Physik*, 68. 11–12. *pp.* 735–757, *April* 20, 1931.—A theory is put forward to account for the experimental results obtained in Parts I and II [see Abstracts 1329 and 1330 (1931)] by Polednik and Lederer respectively. To obtain the general conditions of equilibrium from which the contact potentials may be calculated, the author adopts the principle that in a system of bodies which are in contact, the potentials can be independent of the time only if the currents due to spontaneous emission of charged particles (electrons and ions) cancel everywhere in the system. The special cases considered are: the contact potentials between a metal and an insulator, between two metals, and those involving electrolytes. The theoretical results agree throughout with the experimental data, and particularly well with those of Part I. A formula is obtained for the contact potential between two insulators which is intimately connected with Coehn's law for charges in dielectrics. H. L. B.

3170. Measurement of Capacities by Means of Thermionic Valves. L. Sesta. *N. Cimento*, 8. *pp.* 114–119, *March*, 1931.—A method of using valves is described with a seconds clock as a measuring instrument. E. E. F. d'A.

3171. Accurate Measurement of Small Electric Charges by a Null Method. L. S. Taylor. *Bureau of Standards, J. of Research*, 6. *pp.* 807–818, *May*, 1931.—In the use of an electrostatic system for measuring charges and currents, it is necessary to know the electrostatic capacity of the system. For small capacities the error in this measurement may easily be 1 %. There is here described a new method for calibrating a null system in such a manner that the capacity of the leads does not enter and which, therefore, permits a reduction in the calibration error to one-tenth. When a system is once calibrated in the manner described, any unknown capacity whatever may be added to the leads without affecting the measurement of the desired quantities. Expressions are given for the sensitivity of the system in terms of readily measured quantities. Applications to the measurement of current, charge and capacity are discussed. AUTHOR.

3172. Temperature Coefficient of the Saturation Current and Its Effect on the Conductivity of Liquid Dielectrics. A. Nikuradse and R. Russischwili. *Ann. d. Physik*, 8. 7. *pp.* 811–820, *April* 1, 1931. —By means of apparatus, consisting of a suitable high-tension generator giving voltages up to some 20 kV, which supplied a potential difference to two plates, suitably guarded and immersed in mineral oil, a study was made of the variation of the saturation current with the temperature. It was found that the saturation current (J_s) at a temperature T° Abs. is related to the current (J_0) at 0° Abs. (found by extrapolation) through the equation $J_s = J_0 e^{\alpha T}$, where α is a constant independent of temperature. G. E. B.

3173. Dielectric Theory and Electric Insulation. J. W. Williams. *Frank. Inst., J.* 211. *pp.* 581–606, *May*, 1931.—Modern dielectric-constant theory is reviewed. It is important, in questions of electric insulation, to know the structures of the simplest molecules, the sizes and shapes of the molecular aggregates, and something concerning the size, form and arrangement of the capillaries of the proposed insulating materials. Methods of ascertaining these data are more or less fully discussed. A. D.

3174. Dielectric Constant of Air at High Pressures. J. W. Broxon. *Phys. Rev.* 37. *pp.* 1338–1344, *May* 15, 1931.—The dielectric constant of aged, dry, dust-free air was measured at pressures up to 170 atmospheres by an electrometric method. It was found to increase linearly with the pressure. AUTHOR.

3175. Dielectric Constants of Solutions of Electrolytes. W. Orthmann. *Ann. d. Physik*, 9. 5. *pp.* 537–569, *May* 20, 1931.—It is shown by static measurements, according to the Fürth ellipsoid method, that strong convection currents arise, and these were avoided by employment of a ballistic method which rendered results free from error up to conductivities of about $0{\cdot}01$ ohm^{-1} cm.$^{-1}$. In order to avoid polarisation as far as possible, silver was used as material for the condenser plates and ellipsoids, whilst solutions of silver salts were investigated. Up to concentrations of $0{\cdot}1$ to $0{\cdot}02$ M. for silver nitrate and silver sulphate, and at frequencies of 50–50,000 hertz, there is an increasing decline in the dielectric constant with increasing concentration and at 5000 hertz the decrease is about proportional to the concentration. A new relation is found for concentrated silver nitrate solutions which is not interfered with by polarisation between 500 and 10,000 hertz. H. H. Ho.

3176. Polarisation and Electric Moment of Tung Oil. A. A. Bless. *Phys. Rev.* 37. *pp.* 1149–1154, *May* 1, 1931.—The molar polarisation of tung oil was determined by the method of mixtures using the relation $P_{1,2} = [(\epsilon - 1)/(\epsilon + 2)](M_1f_1 + M_2f_2)/d = P_1f_1 + P_2f_2$, where ϵ is the dielectric constant; d the density of the solution; f_1f_2, M_1M_2, and P_1P_2 the mole fraction, molecular weight and polarisation of the two components respectively, and found to be about 360 c.c., the moment being $2{\cdot}29 \times 10^{-18}$ e.s.u. The above equation is found to hold for all concentrations, showing that the clustering of the molecules is such as to neutralise the internal field. The values of the moment of tung and of ethyl ether were determined from the variation of the polarisation with temperature and do not agree with the data from the method of mixtures. The explanation suggested is that the internal field can never be completely eliminated, whereas the above data are obtained with internal field neglect as a simplifying assumption. H. H. Ho.

3177. Free Rotation and Temperature Dependence of Molecular Polarisation of 1 : 2-Dichloro-ethane. R. Sänger. *Phys. Zeits.* 32. *pp.* 414–415, *May* 15, 1931.—To avoid any misunderstanding which might arise from the criticism of L. Meyer [see Abstract 2891 (1930)], the author now summarises the results of his experimental work in this field. [See Abstract 1990 (1931).] H. H. Ho.

3178. Geophysical Factors in Liability to Lightning Stroke. L. N. Bogoïavlensky. *J. de Physique et le Radium*, 2. *pp.* 101–113, *April*, 1931.—At two places, about 200 km. S.W. of Leningrad, the con-

ductivities of (*a*) the air in immediate contact with the soil and of (*b*) the soil were determined over an area of about ½ sq. km. To determine (*a*) the ionisation due to penetrating radiation was measured by a special electrometer; for (*b*) resistivity and spontaneous polarisation methods were employed. The Gerdien apparatus was found unsatisfactory. By contoured plans it is clearly shown that liability to lightning stroke is greatest where conductivity is highest. C. A. S.

3179. Demonstration of Migration and Charge of Ions in the Atmosphere. H. Greinacher. *Phys. Zeits.* 32. *pp.* 406–410, *May* 15, 1931.—A ring of thick wire is supported on insulators and joined to an electroscope. A pointed wire ioniser is at the centre of the ring and joined to one terminal of a Wimshurst machine, thus providing + or − ions as desired inside the ring. Observation of the electroscope leaves, visually or photographically, can be used with a charging or discharging method to obtain the relative mobilities of the + and − ions. The mean ratio, negative to positive, is 1·22, while dry air gives 1·35 and damp air 1·10. For charged dust particles the same speed is obtained for + or − ions. The effects of the slower moving charged dust particles on the measurement of relative mobilities for atmospheric ions are discussed. R. S. R.

3180. Inversion of Magnetic Inclination through Geological Ages. P. L. Mercanton. *Comptes Rendus*, 192. *pp.* 978–980, *April* 20, 1931.—Particulars are given of a study of the remanent magnetism of various samples of volcanic lava from both hemispheres and of different geological ages. The results indicate that at tertiary epochs at the time of large volcanic eruptions, the terrestrial magnetic inclination was opposite to that existing now in the two hemispheres. R. S. R.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

3181. Electrical Resistance of Nickel and Iron Wires in Longitudinal Magnetic Fields. O. Stierstadt. *Phys. Rev.* 37. *pp.* 1356–1366, *May* 15, 1931.—In a paper on electrical resistance of nickel and permalloy wires as affected by longitudinal magnetisation and tension, L. W. McKeehan [see Abstract 587 (1931)] pointed out that further investigation and discussion of some special questions regarding change of resistance of ferromagnetic substances in magnetic fields were highly desirable. In the present paper the following subjects are treated, partly on the basis of hitherto unpublished measurements by the author. (1) Change of resistance in small fields. As the literature shows, the question whether this is independent of the magnetic history of the sample is not yet settled. Anomalies often observed are not real. (2) The early saturation of the magneto-resistance effect, a condition which is reached in considerably weaker fields with ferromagnetic than with para- and diamagnetic bodies. An explanation on the basis of the electron theory is suggested. Author.

3182. Theory of the Electric Contact. W. Ehrenberg and H. Hönl. *Zeits. f. Physik*, 68. 5–6. *pp.* 289–308, *March* 24, 1931.—On the basis of the Fermi-Sommerfeld statistics of the metal electrons and of wave mechanics, the passage of currents over a place of contact is investigated. It results that the strength of current under normal conditions

remains practically constant up to a distance apart of the ends of the conductor of 10 Å., although the penetrability of the place of contact calculated by wave mechanics only amounts to about 10^{-9}, and then the coefficient is quickly immeasurably small. Further, it appears that an explanation of the detector action on the ground of the assumptions made is not possible. J. J. S.

3183. Part of Protons in Electrical Conduction in Metals. D. P. Smith. *Zeits. f. Physik*, 69. 3–4. *pp.* 253–258, *May* 1, 1931.—Refers to a recent investigation by Coehn and Specht [see Abstract 3519 (1930)] on the "supplementary" conduction produced by the electrolytic occlusion of hydrogen in palladium, and mentions a number of previous experiments made by the author and others bearing on the same point. Owing to the fall of potential due to the measuring current, a diminution in concentration of the ions in one direction and of neutral atoms in the other is brought about, and this produces diffusion phenomena, which account for the supplementary conduction. Conduction of this kind does not obey Ohm's law, and this has been found experimentally to be the case, the resistance depending on the current as in the Geissler tube. It is possible to obtain the same action with oxygen instead of hydrogen, though the amount of this supplementary conduction is small. Calls attention to the difference between the author's views and those of Coehn and Specht. H. N. A.

3184. Current Conduction by Thin Glass Films in Intense Fields. W. Hubmann. *Ann. d. Physik*, 9. 6. *pp.* 733–755, *May* 28, 1931.—Glass films, 1 to 4 μ in thickness, are subjected to constant and very intense electric fields of about 10^6 volts/cm. for a considerable time. The resulting currents of the order of 10^{-7} ampere are plotted against the time. The curves fall into three main parts, for which the current has decreasing values. The time taken for a steady state to be reached depends on the nature of the electrodes, being less for mercury and more for sodium amalgam or acidified water. The relation between the current and the potential does not correspond with Ohm's law, but can best be represented by exponential functions. The results of subjecting various types of glass to intense fields for a long time are described in detail. H. L. B.

3185. Resistivity of Crystallised Lead Sulphide. G. S. Frey. *Arkiv f. Kem. Min. och Geologie, Stockholm*, 10. 9. *pp.* 1–27, 1931.—Lead sulphide is prepared by dissolving pure lead in HNO_3 and precipitating by H_2S. The resistivity formula is $w_0 = 0{\cdot}00258(1 + 0{\cdot}00895t + 0{\cdot}000022t^2)$. E. E. F. d'A.

3186. Density and Conductivity of Bismuth Single Crystals Grown in Magnetic Fields with Relation to their Mosaic Structure. A. Goetz and A. B. Focke. *Phys. Rev.* 37. *pp.* 1046–1056, *May* 1, 1931.—Half of each single crystal was crystallised within, and the other half outside of, a strong magnetic field, in the manner described by Goetz and Hasler. A difference in density was found between the "normal" and the magnetic half, the sign of which depended on the orientation with which the crystal entered the field. Details are given as to this change in sign. The difference in density is about 0·3 %, but can be many times greater in imperfect crystals. The purity of the metal affects the change of density, and it appears as if the ideally pure metal would not be affected by the magnetic treatment. There is a small change in specific

resistance between the normal and magnetic half of the crystals. In case the orientation is such as to decrease the density, the resistance increases, and *vice versa*. The change is of the order of 0·5 %. It seems probable that the influence of the magnetic field on the formation of a crystal consists of a change within the mosaic structure of the lattice. The investigation is being continued. H. N. A.

3187. Directional Dependence of the Electrical Discharge through Crystals. J. Lass. *Zeits. f. Physik*, 69. 5–6. *pp.* 313–331, May 12, 1931.—Discharge experiments through crystals of rock-salt, fluorspar and calespar are described, the course of the discharge being found to be dependent on the crystallographic structure. Microscopic data are included. Orientated channels remain distinct at the temperature of liquid air, but above 600° C. another type of discharge path occurs and the direction of maximum field strength is preferred. H. H. Ho.

3188. Spark Gaps. A. Guillet. *Comptes Rendus*, 192. *pp.* 876–878, *April* 13, 1931.—Gives data for computing the forces along the actual spark in plane-and-sphere and in sphere-and-sphere spark gaps. A. D.

3189. Kathode Sputtering of Elements and Some Applications. F. Joliot. Parts I and II. *Ann. de Physique*, 15. *pp.* 418–454, *April*, 1931.—The first part deals with the technical details involved in preparing thin films of definite thickness. A sketch of the apparatus and many details are given for depositing films on supporting layers of rock-salt and other substances, and it is also shown how to prepare unsupported films. Some applications of these films to electrochemical researches are described. The second part gives an account of the way in which the properties of thin films of a metal differ from those of plates of ordinary thickness. The properties of thin films prepared by thermal deposition (subliming) are compared with those found by sputtering, and it is concluded that they have a similar crystalline structure. The variation of the coefficient of resistance with temperature is also studied. H. L. B.

3190. Preparation of Alkali Metals in Discharge Tubes. Magdalene Forró and E. Patai. *Zeits. f. techn. Physik*, 12. 5. *pp.* 256–262, 1931.—A method of producing a mirror of pure alkali metal *in vacuo* is developed. Under certain conditions sodium atoms can be replaced by atoms of other alkali metals. The resistance of the glass is found to increase in proportion to the quantity of the alkali metal introduced. Up to thicknesses of 15 μ the replacement of the sodium atoms is reversible. The behaviour of potassium, rubidium and cæsium is investigated under the same conditions. F. J. B.

3191. Anode Atomisation. M. Bareiss. *Zeits. f. Physik*, 68. 9–10. *pp.* 585–590, *April* 13, 1931.—An experimental investigation was made as to whether rebounding electrons give rise to any appreciable anode atomisation analogous to the kathode atomisation due to rebounding kations. A preliminary experiment indicated that such an anode atomisation might exist, but further experiments with improved methods showed that in the case of gold the rebounding of 220-volt electrons and also of 800-volt electrons produced no appreciable effect. The electron current strength was of the order of 4·5 to 5 mA., and the duration of the experiments up to 57 hours. A. W.

3192. Alternating Corona Discharge with Oxidised Copper Electrodes. A. v. Engel. *Zeits. f. Physik*, 68. 11–12. *pp.* 768–773, *April* 20, 1931.—An investigation of the lessening of the corona discharge between electrodes when they are covered with a thin layer of copper oxide. An explanation of the effect is given in terms of the higher kathode fall with copper oxide than with copper surfaces. A. C. M.

3193. Potential Drop and Ionisation at a Mercury-Arc Kathode. E. S. Lamar and K. T. Compton. *Phys. Rev.* 37. *pp.* 1069–1076, *May* 1, 1931.—By means of a movable Langmuir collector, the potential, ion concentration and electron temperature were measured at various distances from a stationary mercury kathode spot, at various arc currents. The results indicated a kathode drop of 10·0 volts, and a small negative potential gradient beyond the fall space which was more pronounced at the larger currents. The ion concentration varied between $2(10)^{13}$ and $3(10)^{11}$ cm^{-3} for distances between 0·4 and 1·7 cm. and arc currents between 11 and 4·2 amperes. The concentrations evidently greatly exceed these values very close to the kathode. The mean electron energies were about 1·4 volts near the kathode and fell to a little less than a volt at the greater distances. From the lack of saturation of currents to the collector at space potential, the coefficient of electron reflection at the amalgamated tungsten collector surface was found to be close to 0·5. It is shown that the thickness of the kathode fall space must be less than $1·76(10)^{-4}$ cm. and that the field at the kathode surface must exceed $7·6(10)^{4}$ volts per cm. AUTHORS.

3194. Theory of the Mercury Arc. K. T. Compton. *Phys. Rev.* 37. *pp.* 1077–1090, *May* 1, 1931.—The theory of heat balance at the kathode is extended, and a test of the two resulting equations shows that Langmuir's theory of extraction of electrons by the field at a mercury-arc kathode is consistent with the kathode heat equations, but cannot be uniquely proved by them on account of uncertainty in two factors whose order of magnitude only is known. An equation is obtained giving the temperature of the kathode spot and the vapour pressure outside it, provided the fraction f of total current carried by electrons is known. The temperature of the kathode spot is shown not to exceed 200° C. The thickness of the kathode fall space is found to be less than the electron mean free path. It is also shown that ionisation just beyond the kathode fall space must be of the cumulative, multiple-stage type. From this an estimate of the value of the fraction f is made. A. W.

3195. Electrodeless Discharge in Mercury Vapour. H. Smith, W. A. Lynch and N. Hilberry. *Phys. Rev.* 37. *pp.* 1091–1101, *May* 1, 1931.—A method is described for studying the characteristics of the components of the electrodeless discharge in mercury vapour. A Hartley oscillator is used to excite the discharge, oscillating currents up to 45 amperes being obtained at frequencies from 5×10^6 to 12×10^6 oscillations per sec. Shield experiments have been performed which clearly show the distinction between the dull glow discharge which is considered electric in its origin and the bright glow discharge which is shown to be electromagnetic in its origin; the dependence of the bright glow on the dull glow or on the effect of some ionising agent is proved. The variation of the current necessary to start the discharge with the pressure of the mercury vapour has been investigated fully over the pressure range 0·002 to 0·2 mm.

of mercury. Curves are drawn and analysed in terms of J. J. Thomson's electromagnetic theory of the discharge and Brasefield's electric theory. It is shown that neither theory is sufficient to explain the experimental facts; the predictions seem to hold for the bright glow with fair agreement, but fail markedly with the dull glow. AUTHORS.

3196. Uniform Columns in Electric Discharges. J. S. Townsend. *Phil. Mag.* 11. *pp.* 1112–1122, *May*, 1931.—The theory previously given by the author to account for the conductivity in the uniform positive column of a discharge through a rarefied gas has been found to give a satisfactory explanation of experiments on the uniform luminous columns obtained either in d.c. or in oscillatory current discharges. The forces required to maintain the discharges are comparatively small and in many cases the mean energy of agitation of the electrons is about three or four volts, so that the mean loss of energy of an electron in a collision with a molecule of the gas is a small fraction of the mean energy. The principal phenomena observed in luminous discharges are due to collisions in which the energies of the electrons are greater than the mean energy. In some of these collisions the molecules of the gas are ionised and in others the energy transfer is great enough to excite radiation. The experiments show that the mean energy of the electrons which excite the red lines of the spectrum is less than for the yellow lines, and this again less than for the green or violet lines. An example of the method of finding the energies of the electrons that excite the lines in different parts of the spectrum was given in a previous paper on the excitation of the He spectrum. In helium it was found that the mean energy of the electrons which excite the lines in the violet spectrum was 11·1 volts, that for the red lines being 10·5 volts, when the mean energy of agitation was between 3·7 and 5·2 volts. In Ne at a pressure of 40 mm. the mean energy of agitation is 4·3 volts and the mean energy of the electrons in the collisions with atoms producing ionisation is 13·5 volts. The experiments on the measurement of the energies of the electrons that excite the lines in different parts of the spectrum of Ne are not yet completed, but the preliminary results are in agreement with the theory here given. A. W.

3197. Peculiar Types of Secondary Lichtenberg Figures. K. Umeda and M. Shôyama. *Tokyo B.D., Sci. Reports*, 1. 7–12. *pp.* 127–132, *May* 23, 1931. *In English.* Secondary and tertiary Lichtenberg figures are taken by means of electrodes of different forms: needle, circular, triangular or rectangular frame, etc. It has been proved that, on modifying the form of an electrode in this manner, the polarity of the electrodes affects not only the diffuseness, but also the form of the secondary and tertiary Lichtenberg figures. With d.c. impulse voltages new types of figures are obtained, such as the primary figure surrounded by a system of parallel closed curves, the diffused blackening surrounded by fan-shaped patterns or after-discharge-like patterns, etc., according to the polarity of the electrodes. Some peculiar types of figures taken at oscillatory voltages, which consist of numerous dots, are added. [See also Abstract 1639 (1931).] AUTHORS.

3198. Ionised Gases and Coulomb's Law. T. V. Ionescu. *Comptes Rendus*, 192. *pp.* 928–930, *April* 20, 1931.—Regarding the relative displacement of positive ions and electrons caused in a gas by an electric field as producing an elastic force, and applying Poisson's equation, the

period of vibration of the electron is deduced as $e\sqrt{N/\pi m}$, where N is the number of electrons per c.c., and e and m have their usual meanings. Assuming that in the absence of a field each electron is midway between two positive ions, and applying Coulomb's law, the period is expressed by $2e/\pi . \sqrt{N/m}$ [see Abstracts 1612 and 3159 (1929)]. Formulæ are then similarly deduced for the velocity of propagation of the electric waves in a tube containing ionised gas: $2e\sqrt{\pi N/m}$ by the former method, $2e\sqrt{6N/m}$ by the latter. This velocity can thus be deduced from the period of vibration of the ionised gas concerned. C. A. S.

3199. Mobility of Aged Ions in Air in Relation to the Nature of Gaseous Ions. N. E. Bradbury. *Phys. Rev.* 37. *pp.* 1311–1319, *May* 15, 1931.—The mobility of gaseous ions in air formed by intense X-radiation has been studied by the method of Tyndall and Grindley. The mobility of ions less than 0·08 sec. of age was found to be 2·21 cm./sec. per volt/cm. for the negative ion and 1·59 cm./sec. per volt/cm. for the positive ion in agreement with values observed by Loeb and by Tyndall and Grindley. A modification of the apparatus permitted the mobility of ions which had been aged for times up to 1·5 sec. to be studied. In this case a decrease in mobility was observed to values of 2·04 and 1·46 for the negative and positive ions after 1·5 sec. ageing. The ionisation chamber and source of ionisation were the same as those employed by Luhr in recombination measurements. From the theoretical mobility equation of Langevin, the observed decrease in mobility cannot be correlated with the probable increase in ionic mass occurring in recombination measurements under the same conditions. A much larger decrease in mobility is predicted on this basis than is observed in these experiments. Author.

3200. Mean Free Path of Electrons. J. S. Townsend. *Ann. d. Physik,* 8. 7. *pp.* 805–808, *April* 1, 1931.—The author replies to some criticisms made by Ramsauer [see Abstract 961 (1931)] about the diffusion method used by Townsend and Bailey to determine the mean free paths of slow electrons in gases. He points out that there is a similarity between the diffusion method and Ramsauer's own method in that in both cases an electronic current moves through a certain distance in a gas and the number of electrons deflected beyond a certain limit is experimentally determined. There are no grounds for saying that the diffusion method is indirect. The ordinary methods of the kinetic theory of gases are used in all experiments of this kind, including Ramsauer's. In neither of the methods under discussion is the mean free path determined directly. It is not easy to see how it is possible to measure directly by an experiment a quantity which cannot be precisely defined physically. **C. Ramsauer** (*ibid.*, pp. 809-810) merely states that the two methods should never have been compared by Brose and Saayman, and that, whereas they tend to surprisingly similar results in some cases, they give considerable differences in others. It would be fruitful to discover the reasons for this different behaviour. H. L. B.

3201. Energy Losses and Scattering of Moderately-Fast Electrons in Nitrogen. M. Renninger. *Ann. d. Physik,* 9. 3. *pp.* 295–337, *May* 2, 1931.—Energy losses of electrons of velocities from 200 to 2000 volts are measured in rarefied nitrogen. In the first part of the paper

measurements are made with electrons that pass on after collision almost in the direction of the primary electrons. In the second part conical diaphragms are used to measure the electrons that are deflected at angles between 8° and 26° from the direction of the primary electrons. At all velocities energy losses occur which correspond to simple excitation of the nitrogen molecule. They occur relatively more frequently in the case of the electrons which are deflected almost in the direction of the primary electrons. The majority of the electrons, when they collide with the molecules, ionise them and transfer to them some of their kinetic energy. The spectrum of energy losses for a wide range of velocities is given in detail. For electrons with a primary velocity of 500 volts, it is possible to obtain from the result a numerical estimate of the primary and secondary excitations and ionisations produced by the collisions. The mean energy loss for each pair of ions leads to a value between 30 and 40 volts. H. L. B.

3202. Validity of de Broglie's Relation for Very Fast Electrons (220 kV). E. Rupp. *Ann. d. Physik*, 9. 4. *pp.* 458–464, *May* 7, 1931.—For swift electrons of $220 \pm 5{\cdot}5$ kV calculations from potential measurements give a wave-length value $\lambda = (2{\cdot}183 \pm 0{\cdot}035) \times 10^{-10}$ cm. From measurements of the ring diameter of the electron interferences in gold foil the wave-length calculated is $\lambda' = (2{\cdot}162 \pm 0{\cdot}013) \times 10^{-10}$ cm. The agreement of these results to about 1 % shows that de Broglie's relation for the dependence of the mass of an electron on its velocity is very approximately correct. A. W.

3203. Radiationless Collision Processes at Low Velocities. P. M. Morse and E. C. G. Stueckelberg. *Ann. d. Physik*, 9. 5. *pp.* 579–606, *May* 20, 1931.—By using wave functions which avoid the complete superposition of two colliding systems, by introducing a suitable potential of the form const./r^2, it is possible to apply certain simple expressions for the interaction of the systems. This enables the authors to calculate the effective cross-sections for different collision processes in which no radiation is emitted. In most cases the results are in good agreement with the experimental values and justify this rough approximation used for the mutual potential. H. L. B.

3204. Angular Distribution of Electrons Scattered by Gas Molecules. C. Ramsauer and R. Kollath. *Ann. d. Physik*, 9. 6. *pp.* 756–768, *May* 28, 1931.—An apparatus is described which allows the ratio of the number of electrons scattered in the forward direction to those scattered in the backward direction after encountering neutral molecules to be determined by a method which gives approximative results. This ratio is called the "scattering ratio." Measurements have been made for the gases He, A and H, the velocities of the electrons ranging from 1 to 25 volts. It is found that the curve which gives the scattering ratio in terms of the electronic velocity is different for each gas. The different curves appear to bear no relationship to the cross-section curves. In general, the scattering ratio increases with the velocity of the electrons. A is an exception, in that between $1{\cdot}5$ to $2{\cdot}75\sqrt{\text{volts}}$ the scattering ratio decreases as the electronic velocity increases. At very low velocities (about 1 volt) the scattering ratio in the three gases in question falls below unity; that is, the scattering in the backward direction exceeds that in the

forward direction. This is particularly pronounced in the case of H, for which the scattering ratio decreases to the value 0·5. H. L. B.

3205. Theories of G. Hertz on the Motions of Slow Electrons in Gases. V. A. Bailey. *Zeits. f. Physik*, 68. 11–12. *pp.* 834–842, *April* 20, 1931.—Hertz's papers on the diffusion of electrons in gases are discussed. The author finds that Hertz's diffusion equation is only a special form of Maxwell's equation for the diffusion of a gas with the unallowable assumption added that the electrons lose no energy in their collisions with molecules. No mention is made in Hertz's papers of the considerable amount of work done in this field by Townsend and his collaborators. It is shown that the assumptions adopted by Franck and Jordan from Hertz's theory to show that slow electrons and helium atoms behave like perfectly elastic spheres when they collide are hardly even of qualitative importance, whereas this has been shown to be the case quantitatively in the experiments of Townsend and Bailey. H. L. B.

3206. Crystal Interferences of Electrons with Spin. H. Hellmann. *Zeits. f. Physik*, 69. 7–8. *pp.* 495–506, *May* 28, 1931.—In the first place the polarisation of electrons when reflected by layers of potential inhomogeneity is discussed qualitatively in terms of Dirac's equations. To the degree of approximation of the first step of the calculation of collisions, it is possible to obtain the effect of the scattering on the polarisation for given electrical inhomogeneities. This approximation certainly gives a rotation of the polarisation vector, but is not sufficient to give information about intensity effects. It gives, however, an indication of the conditions which are favourable for the production of a polarisation in periodic fields. For ideal crystals, information about polarisation effects can be obtained by means of the dynamical theory of crystal interferences. H. N. A.

3207. New Type of Selenium Cell. L. Bergmann. *Phys. Zeits.* 32. *pp.* 286–288, *April* 1, 1931.—This a further development of Lange's "blocking layer" (*Sperrschicht*) cell, in which the light falls upon a limiting layer between two conductors which has a unipolar conductivity [see Abstract 1381 (1931)]. The blocking layer is generally a film of cuprous oxide, in which case the photoelectrons move from the cuprous oxide to the copper. The author has found a similar effect of a blocking layer in the iron selenium rectifier brought out by a Nürnberg firm. Iron covered with selenium has a thin interrupted coating of lead sprayed on it. The ratio of the resistance is 1:2500 at 5 volts. On illumination, the electron current proceeds from iron to selenium, *i.e.*, against the blocking action. The current obtained from a 40-watt lamp at 20 cm. is 14 microamps. The maximum sensitiveness is in the red. E. E. F. d'A.

3208. Variation of Photoelectric Current with Temperature and Potential. D. Ramadanoff. *Phys. Rev.* 37. *pp.* 884–896, *April* 15, 1931.—With constant plate voltage the photoelectric current increases gradually with the temperature and at about 600° C. is nearly twice as large as at ordinary temperatures. As the temperature is increased to 750° C. the increase in photoelectric current for steady illumination is 100-fold, while for interrupted illumination it is only 17-fold. The difference is probably due to the elimination of sluggish currents produced in a secondary way. E. E. F. d'A.

3209. Atomic Photoelectric Effect Excited by Very Hard Rays. F. Sauter. *Ann. d. Physik*, 9. 2. *pp.* 217–248, *April* 25, 1931.—Completes the work of Sommerfeld and Schur [see Abstract 2651 (1930)] on the direction of the photoelectrons emitted by the K and L shells. Develops the theory of the photoelectric effect by the Dirac equations. Criticises the work of Szczeniovski and of Muto. E. E. F. d'A.

3210. Angular Distribution of Photoelectrons Ejected by Polarised Ultra-Violet Light in Potassium Vapour. M. A. Chaffee. *Phys. Rev.* 37. *pp.* 1233–1237, *May* 15, 1931.—Light of wave-lengths in the region of 2400 Å. selected by a monochromator and polarised by a pile of quartz plates illuminated a jet of potassium vapour. The lateral directions of emission of the photoelectrons relative to the electric vector were studied. Though the electrons were ejected with energies less than one equivalent volt, the experiments were definite in establishing that the most probable direction of ejection is that of the electric vector and that the angular distribution varies as the square of the cosine of the angle between the electric vector and the direction in question. This result is in accord with predictions of wave mechanics for a spherically symmetrical atom, and incidentally, therefore, constitutes additional evidence that molecules do not play an appreciable part in the observed photo-ionisation of potassium vapour. AUTHOR.

3211. Photoelectric Properties of Gold. L. W. Morris. *Phys. Rev.* 37. *pp.* 1263–1268, *May* 15, 1931.—Variations in the photoelectric behaviour of a gold filament were studied both during an extended outgassing, and later upon reaching a stable condition. Full arc sensitivity rose quickly in the initial period, then decreased slowly to a stable value. Fatigue curves showed a systematic change from a negative fatigue (*i.e.*, a decrease in sensitivity with time of standing) at the beginning to a gradually increasing positive fatigue which slowly decreased to zero. A shift in long-wave limit consistent with the change in full arc sensitivity was observed. Changes in photoelectric properties were measured for increasing temperature. Full arc sensitivity decreased slightly. Individual line sensitivity was studied by use of a quartz double monochromator. Lines close to the long-wave limit increased enormously in sensitivity with temperature, for those more removed this was less marked, while below 2350 Å. there was a slight decrease. A shift in long-wave limit toward the red was observed during the outgassing period and the final fatigueless state. During this latter period photo-current per unit light intensity curves established a shift in long-wave limit from 2560 Å. to 2610 Å. between temperatures of 20° and 740° C. AUTHOR.

3212. Photoelectric Properties of Silver. R. P. Winch. *Phys. Rev.* 37. *pp.* 1269–1275, *May* 15, 1931.—Silver was carefully outgassed and its photoelectric properties studied during outgassing and after stable conditions were reached. An outgassing curve was plotted for the 1200 hours of heat treatment of the silver before final readings were taken. For thoroughly outgassed silver curves were plotted showing photoelectric emission as a function of temperature for fixed wave-lengths of incident light. These curves show that for wave-lengths near the long-wave limit there is a marked increase in emission with temperature, for wave-lengths farther away there is no change with temperature, and for wave-lengths still farther away there is a slight decrease in emission with

increased temperature. Curves for emission per unit of incident light intensity as a function of wave-length show that the long-wave limit at 600° C. is 2700 ± 20 Å. while at room-temperature it is 2610 ± 30 Å.

AUTHOR.

3213. Thermionic Emission of Melting Metals. Irmgard Ameiser. *Zeits. f. Physik*, 69. 1–2. *pp.* 111–140, *April* 23, 1931.—In silver, gold, and copper there is a discontinuity of the Richardson line at the melting point, the electron emission falling off while the metal passes into the liquid condition. The energy of emergence, however, remains the same in both conditions. E. E. F. d'A.

3214. Resistance of Oxide Layer on Incandescent Kathodes. J. Kroczek and E. Lübcke. *Wiss. Veröff. a. d. Siemens-Konzern*, 9. 2. *pp.* 252–261, 1930.—The radial resistance of the oxide layer is determined by the rate of heating by emission. The Richardson line permits a calculation of the energy of emergence. The resistance depends upon the temperature and the process of formation, but is less than that usually found for BaO. The minimum energy of emergence was 0·945 volt.

E. E. F. d'A.

3215. Electric Spectrum of Water in Region of Wave-Length 2·5 m. M. Alimowa. *Ann. d. Physik*, 9. 2. *pp.* 176–178, *April* 25, 1931.—Novosilzew [see Abstract 1598 (1930)] has previously investigated the region of the spectrum 2–4 m., using undamped waves. The author has obtained results by using a damped system, which agree with those of Nowosilzew. The mean value of the refractive index at 17° C. is 9·004, with a probable error of 0·001. H. M. B.

3216. Examination of Piezoelectric Quartz Plates. P. T. Kao. *Rev. d'Optique*, 10. *pp.* 153–161, *April*, 1931.—For piezoelectric purposes a circular or parallelepipedical plate of quartz is cut accurately normal to one of the binary (electric) axes; if parallelepipedical, the sides are normal to the optic axis and to the " third " or piezoelectric axis, which is normal to both optic axes and an electric axis. When etched with hydrofluoric acid the negative face is always attacked more readily than the positive. A method is described for accurately determining the axes and detecting " electric " twins, depending on microscopic examination of etched figures so obtained. C. A. S.

3217. Series Laws for the Elastic Proper-Frequencies of Quartz Rods. Part I. Longitudinal Vibrations. E. Giebe and A. Scheibe. *Ann. d. Physik*, 9. 1. *pp.* 93–136, *April* 17, and 9. 2. *pp.* 137–175, *April* 25, 1931. *From the Reichsanstalt.*—Forty-six rods are examined in a manner similar to that used previously by the authors [see Abstract 1392 (1928)], to study longitudinal, transverse and torsional vibrations of quartz rods under piezoelectric excitation. All the rods (except two, which are circular) have rectangular or square cross-sections. The axis of the rod is perpendicular to the optic axis, and either perpendicular (Case I) or parallel (Case II) to the electric axis. The modulus of elasticity along the axis of the rod is $1{\cdot}265_2 \times 10^{-12}$ for Case I and $1{\cdot}277_2 \times 10^{-12}$ cm.²/dyn. for Case II, with a mean error of ± 0·6 per thousand. The difference of 1 % between values of the moduli in the two orientations, while appearing to contradict crystallographic symmetry, is explained by the action of a secondary field and deduced theoretically. For small thicknesses of rods, Rayleigh's theory holds for the deviation of the proper-frequencies from

whole number multiples of the fundamental, but the deviation from this theory is very great when the longer side of the cross-section is greater than 0·5 times the elastic half wave-length. This is partly due to resonance between an axial overtone and a lateral (or transverse) fundamental and partly to distortion caused by torsional vibrations. Two empirical laws are obtained, one having two arbitrary constants and the other a third constant equal to Poisson's ratio. Near to resonance between the axial proper frequency and the lateral fundamental frequency, several frequencies are observed. These frequencies are termed a band-spectrum. Frequencies are observed and measured up to the third harmonic of the fundamental lateral frequency. The results indicate the best orientation of the rod for obtaining normal frequency in wireless practice. H. M. B.

3218. Influence of Surrounding Medium on the Frequency of an Oscillating Quartz Crystal. E. Grossmann and M. Wien. *Phys. Zeits.* 32. *pp.* 377–378, *May* 1, 1931.—A rectangular quartz rod with a natural frequency of 98,100 p.p.s. in its longitudinal mode was used in the grid circuit of a transmitter. The crystal electrodes were formed by silver-plating two opposite faces, and opposite one end of the crystal an ebonite disc, 34 mm. in diameter, was fitted to reflect the sound waves from the end of the crystal. The position of the disc with respect to the end of the crystal could be varied by means of a micrometer screw. The frequency of the crystal oscillator was measured by comparison with a second oscillator of constant frequency as the distance between the end of the crystal and the reflector plate was progressively increased. It was found that the frequency varied periodically with the distance in multiples of $\lambda/2$ in air, the total frequency change for small distances between crystal and plate being about 70 p.p.s. A similar effect was observed when using the quartz crystal as an acoustic receiver. For this the crystal electrodes were shunted by a detector and galvanometer, the reflecting disc being situated near one end of the crystal. A second crystal of the same frequency was used in an oscillator whose frequency could be slightly varied by means of a condenser in series with the crystal. The two crystals were similarly situated and about 25 mm. apart. For each position of the reflecting disc the oscillator frequency was adjusted to resonance, as indicated by the galvanometer deflection. It was again found that the frequency varied periodically in multiples of $\lambda/2$ in air. The effect is important from the point of view of the constancy of quartz-controlled transmitters; it can be eliminated by using the quartz crystal in an evacuated chamber or can be minimised by the use of sound-absorbent material for the walls of the chamber containing the crystal or by using hydrogen or CO_2 instead of air in the chamber. [See also Abstract 2812 (1929).] A. W.

3219. Electric L.F. Oscillator Stabilised by a Tuning-Fork. G. Mabboux. *Comptes Rendus*, 192. *pp.* 1154–1156, *May* 11, 1931.—The device consists of replacing the piezoelectric quartz plate ordinarily used by a single coil placed between the prongs of a tuning-fork. One end of the coil is connected to the grid of a triode valve, the other through a condenser with the rest of the circuit. C. A. S.

3220. Magnetic Behaviour of Phosphors. H. Buchner, W. Gerlach and E. Rupp. *Ann. d. Physik*, 8. 7. *pp.* 874–876, *April* 1, 1931.—Rupp's paper on the above subject [see Abstract 1119 (1926)], in

which the susceptibility is measured from the change which takes place in the speed of fall of a phosphor particle in oil when a magnetic field is applied, is discussed. His derivation of the susceptibility is examined and a more accurate formula is found. G. E. A.

3221. Magnetic Permeability for Short Electric Waves. R. Michels. *Ann. d. Physik*, 8. 7. *pp.* 877–898, *April* 1, 1931.—The dependence of the magnetic permeability upon the frequency of the imposed alternating field is investigated for short electric wave-lengths and the existence of a so-called magnetic spectrum of Arkadiew and anomalous effects in the initial permeability is tested. The experiments are performed upon electrolytic iron and upon Russian iron. For electrolytic iron the value of μ_n varies by about 10 %, *i.e.*, within the limits of experimental error. With the Russian wire the measurements were more accurate and in consequence the whole range of the phenomena was examined. The results of Sokolow are criticised in the light of the present work and it is shown that the increase of the permeability value due to him is within the limits of experimental error. The work of Kartschagrin on the variation of permeability is similarly criticised. The value of the initial permeability μ_n is shown for both electrolytic iron and Russian wire to be the same for h.f. as for l.f. waves. The explanation is afforded by the theory of Forsterling as being due to a surface effect. Tables of results, full experimental details and curves are given. [See also following Abstract.] S. G. B.

3222. Surface Effect on Ferromagnetic Wires at High Frequencies. M. Wien. *Ann. d. Physik*, 8. 7. *pp.* 899–904, *April* 1, 1931.—A theoretical note on the findings of Michels [see preceding Abstract] regarding the fact that with high frequencies the surface or skin effect upon the resistance of ferromagnetic wire works differently from the effect upon the self-induction. The permeability computed from the resistance is therefore considerably greater in value than that obtained from the self-induction. The theory that the short waves are unable to penetrate the material to any depth is discussed. Reference is made to the probable relationship of the phenomena to the Hagen and Rubens observation that the infra-red waves excite no ferromagnetic effects, thereby following the conclusion that in consequence of the skin effect the waves are unable to penetrate the surface layer of the material of the wire. S. G. B.

3223. Permeability of Iron, Nickel and Cobalt between 10^6 and 10^7 Hertz. M. J. O. Strutt. *Zeits. f. Physik*, 68. 9–10. *pp.* 632–658, *April* 13, 1931.—Measurements on samples of Russian materials from iron, nickel and steel have given rise to strongly marked anomalies when h.f. permeability is considered in relation to the wave-length, particularly up to about 100 m. By means of a specially constructed vacuum thermo-cross, the permeability of Fe, Ni and Co between 10^6 and 10^7 hertz has been investigated; at room-temperature, in liquid air, and in a tolerably constant magnetic field of about 9000 gauss the value of the permeability has been measured with a maximum error of 2 %. Under these conditions no anomaly as regards permeability which would be greater than the experimental error was identified. The present work was also unable to establish any effect on the permeability due to frequency in relation to the previous thermal history or treatment of the material under test. S. G. B.

3224. Magnetic Susceptibility of Neodymium Nitrate. P. W. Selwood. *Am. Chem. Soc., J.* 53. *pp.* 1799–1805, *May*, 1931.—The

magnetic susceptibility of neodymium nitrate in aqueous solution decreases with increasing concentration. This behaviour is discussed in connection with charges in the absorption spectrum and refraction previously observed [see Abstract 1218 (1931)], and with reference to Fajans' theory of deformable electron shells. C. B. A.

3225. Susceptibility of Oxygen at Low Pressures. E. C. Wiersma, W. J. de Haas and W. H. Capel. *K. Akad. Amsterdam, Proc.* 34. 4. *pp.* 494–497, 1931. *Comm. No.* 215*b of the Phys. Lab., Leiden.*—The apparatus used by the authors for investigating NO at low temperatures was employed. Deviations from Curie's law have been found, which agree, within the limits of available accuracy, with those obtained by Woltjer, Coppoolse and Wiersma for gaseous oxygen at high densities. The results do not agree with those of Perrier and Kamerlingh Onnes for liquid oxygen. H. N. A.

3226. Magnetism and Molecular Structure. Part III. Influence of Geometrical Isomerism on Diamagnetic Susceptibilities. S. S. Bhatnagar, R. N. Mathur and M. B. Nevgi. *Zeits. f. Physik*, 69. 5–6. *pp.* 373–379, *May* 12, 1931.—A sensitive magnetic balance already described by Bhatnagar and Mathur was employed, some small alterations being made to it. It was found that except in one case the cis-isomer is always more diamagnetic than the trans-isomer, though the differences are very small. In the one case in which this rule does not hold, this is accounted for by the fact that the cis-isomer is a solid and the trans-isomer a liquid, since the susceptibility of many organic substances increases when they melt. In Part II [see Abstract 2802 (1931)] the difference in diamagnetism between *o*- and *p*-isomers was explained by considering the radii of the common electronic orbits of the molecules, and the authors show that when the benzene ring is replaced by the ethylene bond, ortho- and para- become cis- and trans-isomers, so that a similar change in diamagnetism is to be expected. H. N. A.

3227. Crystal Structure and Magnetic Properties of Ferrites. H. Forestier. *Comptes Rendus*, 192. *pp.* 842–845, *April* 7, 1931.—In a previous paper the authors have shown the method of preparation of bodies of the general formula, Fe_2O_3 . M . O., where M may be various metals in succession. The magnetic properties of such compounds vary according to the nature of M. The ferrites of Cu, Ni and of Mg have a high magnetisation coefficient, the variability with temperature presenting phenomena similar to those of natural magnetite. The ferrites of Sr, Ba and Pb have a lower magnetisation coefficient and give thermomagnetic and dilatometric curves different from the above in that the anomalies at the Curie point are much less marked. The ferrites of Cd and Ca, of which the magnetisation coefficient is intermediate between these other two classes, practically attain saturation at about 200 gauss. These two bodies lose their magnetism in an irreversible manner after receiving sufficient treatment at a high temperature. The study of the structure of these ferrites has now proceeded by means of X-ray analysis and the results reveal the probable causes of the above phenomena. The ferrites of Cu, Fe, Ni and Mg show a spinellar structure, analogous to natural magnetite with a parameter of between 8 and 9 Å. The structure of the ferrites of Sr, Ba and Pb shows a cubic form in general. In effect, therefore, the results show that the differences in properties enumerated above can

be attributed to differences in structure, the ferromagnetism being much more marked in the spinellar type, zinc ferrite being the only exception. The cases of Cd and Ca ferrites show that a change of structure is able to cause the ferromagnetism entirely to disappear. The magnetic moment of the atom of iron in the unstable form exhibits great mobility. [**Errata**, *ibid.*, p. 1064, April 27, 1931.] S. G. B.

3228. Theory of Fine Structure of Magnetisation Curves of Monocrystals. N. Akulov. *Zeits. f. Physik*, 69. 1–2. *pp.* 78–99, *April* 23, 1931.—Continuing his recent paper [see Abstract 2442 (1931)] in which formulæ are derived for calculating the magnetisation curves of regular monocrystals, the author describes a second, more accurate method of doing this. The magnetostriction is also calculated for monocrystals as a function of the magnetisation by means of the same method. The results obtained agree with experiment; and, in particular, reproduce fine peculiarities in the magnetisation curves. H. N. A.

3229. Magnetic Properties of Crystals. Measurement of Magnetic Fields. G. Dupouy. *Ann. de Physique*, 15. *pp.* 495–591, *May–June*, 1931.—Part I records the measurement of the coefficients of magnetisation of crystals of $FeCO_3$, $MnCO_3$ and Fe_2O_3. The thermal variation of each of the principal magnetisation coefficients was determined for each substance. The two former were found to follow Weiss' law, but the Fe_2O_3 was otherwise. The $FeCO_3$ exhibited particularly high degrees of magnetic anisotropy and was used to measure the strength of magnetic fields. Part II records the development and use of a "gaussmeter," an instrument for direct reading of magnetic field strength. An anisotropic crystal is placed in a magnetic field and is subjected to a couple of magneto-crystalline origin, which tends to orientate its axis of greatest magnetisation parallel to the lines of force in the magnetic field. This couple is neutralised in effect either by application of a weight or by torsion of a spiral. The technique and range of use of the instrument are fully described. Part III is devoted to the use of the crystals for the topographic plotting and investigation of the strength of a magnetic field. S. G. B.

3230. Anomalous Magnetic Properties of the Anhydrous Cupric Chloride and Sulphate at Low Temperatures. Field Dependency of Paramagnetism. W. J. de Haas and C. J. Gorter. *K. Akad. Amsterdam, Proc.* 34. *pp.* 317–324, 1931. *Comm. No.* 215*a from the Phys. Lab., Leiden.*—The completion of earlier experiments [see Abstract 1670 (1931)] on the magnetic properties of anhydrous chlorides. Using previously described methods, the susceptibility of $CuCl_2$ was measured between 373·3° K. and 14·42° K. The law of Curie-Weiss is not followed by this salt at higher temperatures, but at low temperatures a maximum susceptibility is found as a function of the temperature. For $CuSO_4$, between 289° K. and 14·20° K., it was found that down to the N_2 region the susceptibility is independent of the field and follows the Curie-Weiss law with $\theta = -77{\cdot}5$ and $p = 8{\cdot}91$ W.M. In the H_2 region a dependence on the field as regards saturation was observed, as also a weak relationship to the temperature. Evidently, therefore, a dependence of the field can exist for substances with a negative value of θ, in contradiction to the theory of Weiss. In explanation it is suggested that non-degenerated fundamental terms are being treated, when χ is independent of the temperature at low temperatures. S. G. B.

3231. Temperature Coefficient of Magnetisation of Water from 0° to 100° C. W. Johner. *Helv. Phys. Acta*, 4. 3–4. *pp.* 238–280, 1931. *In German.*—Describes a new determination of the relation between the specific susceptibility of water and the temperature. A U-tube method was employed. A magnetic field could be produced round one of the branches about the meniscus, and the other vertical branch B could be raised and lowered, since the horizontal part of the U was long and flexible. This was adjusted, after the field was introduced, until the meniscus in B stood at the same point in the tube as before, when the meniscus in the other vertical branch also came to its original position, since the volume of the water and also the volume of the tube remained the same. The amount through which B was moved measured the magnetic effect. It was found that for equal masses, water becomes more diamagnetic with rising temperature, in accordance with the following equation: $\chi_t = \chi_{20°}\{1 + 0{\cdot}00013(t - 20°)\}$. The reasons for this behaviour have not as yet been explained. H. N. A.

3232. Influence of the Field upon the Magnetic States of Platinum. P. Collet and G. Foëx. *Comptes Rendus*, 192. *pp.* 930–932, *April* 20, *and pp.* 1213–1215, *May* 18, 1931.—The existence has been noted of manifold magnetic states of platinum, and the present work seeks to attribute to its proper cause the particular phenomenon exhibited under the various conditions of field strength employed. Fields of 6000, 9300 and 14,000 gauss were employed and then the phenomena were observed at low fields of approximately 3000 gauss. At each field value the observations were taken over a range of temperatures from − 180° to + 200° or even 400°. The graph of the inverse of the coefficient of magnetisation as a function of the temperature is plotted and forms, for each series of experiments, several segments of straight lines which cut each other at a definite angle, thereby implying that there are discontinuous changes at the Curie point. The reversible phenomena and the straight lines are determined for each individual sample. The results are given in a series of statements. At low fields a new phenomenon is exhibited, in that after several reheatings from a temperature of − 180° to 0°, in the subsequent interval up to 30°, the coefficient of magnetisation is independent of the temperature. This point is discussed. S. G. B.

3233. Ferromagnetic Saturation of Elements other than Fe, Ni and Co, and the Periodic System. C. Sadron. *Comptes Rendus*, 192. *pp.* 1311–1313, *May* 26, 1931.—The ferromagnetic condition of spontaneous orientation may be obtained in non-ferromagnetic atoms by surrounding these atoms with suitable neighbours. The effect of atoms of Ni and Co on atoms of other metals was observed, and the magnetic moments of a number of alloys were measured for varying percentage content of the non-ferromagnetic element. The moment is then found in terms of the magneton. Cr, Mo and W in nickel have nineteen magnetons, and their atoms set themselves antiparallel to those of the nickel. Atoms of Pd in nickel and of Pt in cobalt orientate themselves parallel to the nickel and cobalt atoms respectively, and Ni, Pd and Pt have three magnetons of magnetic moment. [See also Abstract 3842 (1930).] G. E. A.

3234. Propagation of Large Barkhausen Discontinuities. K. J. Sixtus and L. Tonks. *Phys. Rev.* 37. *pp.* 930–958, *April* 15, 1931.—Large Barkhausen discontinuities in nickel wires and hard-drawn wires

of nickel-iron under stress, previously observed by Preisach and Forrer, have been identified as occurring in the form of propagation along the wire originating at a nucleus. For a fixed tension on the wire, the velocity of propagation v was found to vary almost linearly with the applied uniform field, so that $v = A(H - H_0)$. H_0 is the value of the "critical field," and varies with the composition, amount of cold working and stress of the wire. Its behaviour with increasing and decreasing tension shows the presence of elastic hysteresis, whilst the value of A is nearly constant for changes of tension, diameter of wire, composition of wire, and is the same for a strip having a value of about 25,000 cm. sec.$^{-1}$ gauss^{-1}. The constancy of the v/H slope for different wires is suggested to indicate that the velocity depends upon surface phenomena. The critical field is believed to represent a threshold value of magnetic field which must be exceeded at all points of the wire before reversal of magnetism can occur. The phenomena found with torsion are more complicated than for tension, the slope of the v/H curve in some cases showing variation with the direction of twist. No new relations to other properties of the alloys tested have been found. If H_0 be identified with coercive field, Becker's theory may be applied, when it appears that in most cases increased elastic tension and increased cold-working stresses shift H_0 in opposite directions. S. G. B.

3235. Theory of Magnetostriction and Curves of Magnetisation. W. Heisenberg. *Zeits. f. Physik*, 69. 5–6. *pp.* 287–297, *May* 12, 1931.—The significance of the hypothesis of spontaneously magnetised elementary regions in the quantum theory of ferromagnetism is examined, and applied to calculate the magnetostriction of iron crystals below the saturation limit. An elastic peculiarity of such crystals is referred to, and Becker's and Akulov's interpretations of hysteresis [see Abstracts 990 and 992 (1931)] are discussed. J. S. G. T.

3236. Theory of Magnetostriction. A. Perrier. *Helv. Phys. Acta*, 4. 3–4. *pp.* 213–237, 1931. *In French.*—Calls attention to the very great complexity of the relations observed between the deformations and the magnetisation of ferromagnetic media, and shows that it is possible to form a coherent theory to account for the varied general aspects of the curves of deformation. Assumes the existence of a relatively large spontaneous internal striction which creates a small anisotropy of the lattice in each elementary group. The external magnetic field has no sensibly direct action on the lattice constants, and the observable effects are external manifestations of the elementary anisotropy, due to rotations of the vectors I_s (spontaneous magnetisation). Reversible rotations are distinguished from irreversible ones. The consequences of the theory are developed in great detail. H. N. A.

3237. Behaviour of Atoms in a Rotating Magnetic Field. P. Güttinger. *Helv. Phys. Acta*, 4. 3–4. *pp.* 144–145, 1931. *In German. Paper read before the Schweiz. Phys. Gesell., Zürich, May* 1, 1931.—The problem is first considered briefly from the point of view of classical electrodynamics, and then in terms of quantum mechanics. With the latter, if the field rotates slowly, the atom turns with it, and the alteration is adiabactic. If, on the other hand, $j = \frac{1}{2}$ and m is at first $\frac{1}{2}$, j being parallel to the original direction of the field, and the field is turned very quickly through 180°, the atom will retain the direction of its impulse axis in space. This configuration corresponds, however, to the quantum state

$m = -\frac{1}{2}$. Between these two limiting cases, when the field rotates at intermediate speeds, there will in general be no stationary states. Expressions are given for the wave function, and for the probability of the spring $m \to k$. The result is a "shaking" action, which is greater the faster the field rotates. H. N. A.

3238. Theorem on the Reversible Variation of the Resistivity of Ferromagnetic Media. A. Perrier. *Helv. Phys. Acta*, 4. 3–4. *pp.* 145–148, 1931. *In French. Paper read before the Schweiz. Phys. Gesell., Zürich, May* 1, 1931.—The author develops one of the quantitative consequences of the general theory of galvanomagnetic effects which he has recently published [see Abstract 233 (1931)]. He finds that the reversible magnetic variation of the conductance is a linear function of the square of the observable magnetisation throughout the whole extent of the process of magnetisation, independently of the law of magnetisation. The author's results agree perfectly with the recent experimental results of Gerlach, Stierstadt, Schneiderhan and Englert. H. N. A.

3239. Magnetic Field of a Circular Cylindrical Coil. H. B. Dwight. *Phil. Mag.* 11. *pp.* 948–957, *April*, 1931.—A number of formulæ are derived for the strength of the magnetic field of a cylindrical coil or solenoid, which apply to certain parts of the field where they have rapid convergence. An indication is given as to the best formula to use for a given case. The collection covers nearly all the field of the coil. G. E. A.

3240. Effect of Small Variations in Pitch upon the Inductance of a Standard Solenoid. C. Snow. *Bureau of Standards, J. of Research*, 6. *pp.* 777–790, *May*, 1931.—A method is described by which the variations in pitch of a single-layer solenoid may be compared with those of the precision lathe screw used to wind it. Assuming that the pitch of the latter is constant, but not known with precision, it is shown how the precision measurements of the length of the windings may be combined with the former measurements to obtain the variation in pitch of the windings relative to an ideal helix whose beginning and end points coincide with the actual one. A mathematical formula for computing the correction δL to the inductance due to this variation in pitch is then developed. This formula requires the graphical integration of a certain function times the deformation, and practical methods of evaluating it are described. Application is made to observations on two standard solenoids and shows that the correction δL to the inductance L may amount to 4 or 5 parts in 100,000 even on the most carefully constructed solenoids. In absolute measurements the correction is, therefore, by no means to be neglected, although it seems hitherto not to have been taken into account in determinations of the ohm. AUTHOR.

APPARATUS AND INSTRUMENTS.

3241. Production of Very Small Currents. L. P. Smith. *Rev. Sci. Instruments*, 2. *pp.* 237–241, *April*, 1931.—Describes a valve for the production of small currents with a very low capacity (two micro-microfarads), so that it may be used to calibrate electrometer systems without appreciably changing their sensitivity. The model described delivers very small currents of known magnitude over a large current range; and it is capable of delivering currents of either sign. A. D.

3242. Feussner Potentiometer. Marion Eppley and W. R. Gray. *Rev. Sci. Instruments*, 2. *pp.* 242–249, *April*, 1931.—An improved

type is described with six contact resistances eliminated and the addition of another standard cell dial, making it possible to adjust the standard cell circuit to five decimal places instead of only four. A. D.

3243. Spark-Free Synchronising Apparatus for Acceleration and Retardation. H. Bock. *Zeits. f. Instrumentenk.* 51. *pp.* 197–204, *April*, 1931.—An arrangement is described by which the pendulum of an hourly clock controlled electromagnetically may, according to need, be accelerated or retarded and without sparking at the electrical contact. A full description is given of the apparatus, while its synchronising action, the magnitude of the energy carried over by the electromagnetic coupling and the flow of the synchronising current are investigated analytically. R. S. R.

3244. Induction Muffle Furnace. R. Perrin and V. Sorrel. *Comptes Rendus*, 192. *pp.* 1026–1029, *April* 27, 1931.—Describes a muffle furnace heated by induction whose efficiency and power factor, when fed by a.c. of industrial frequency, are considerably above those of the models at present in use. In addition, it regulates its own temperature. It consists of a hollow body of ferromagnetic material traversed by a magnetic flux induced by a solenoid carrying the a.c. This is surrounded by a non-magnetic conducting envelope. The currents induced in the latter by the ferromagnetic material raise its temperature until the material reaches its Curie point, after which the temperature falls. The temperature of the furnace is thus self-stabilising. Furnaces may in this way be stabilised for any temperature from 15° to 1100° C. E. E. F. d'A.

3245. Method for Measuring High Voltages or Low Capacitances. J. A. van den Akker. *Rev. Sci. Instruments*, 2. *pp.* 290–292, *May*, 1931.—A voltage-measuring device is described which absorbs very little energy, and, in this regard, is equivalent to a resistance of 300 megohms, which accurately follows Ohm's law. H. H. Ho.

3246. Piezoelectric Gauge. R. A. Webster. *Frank. Inst., J.* 211. *pp.* 607–615, *May*, 1931.—Describes a piezoelectric gauge and a resistance-coupled amplifier for recording gun pressures. The gauge was tested in a bomb wherein pressures as high as 30,000 lbs. per sq. in. were reached. It is found that a 200-megohm insulation resistance to ground is necessary for proper amplifier response, this resistance having been maintained in wet weather. Good records of as much as an inch amplitude were obtained using standard oscillograph vibrator. In order to determine the distortion of the amplifier, known quantities of electricity were discharged into a known circuit. These tests indicated that the amplifier responded alike to constant charges impressed at different potentials. Variations from calculated values are less than 2½ %. E. E. F. d'A.

3247. Ballistic Recorder for Small Electric Currents. E. B. Moss. *Phys. Soc., Proc.* 43. *pp.* 254–257; *Disc.*, 258, *May* 1, 1931.—The standard thread recorded is so modified that it records ballistic throws in place of the usual steady deflection. By this means the current sensitivity may be increased at least twenty-five times. AUTHOR.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3248. Erythema Due to Ultra-Violet Radiation. E. Q. Adams, B. T. Barnes and W. E. Forsythe. *J.O.S.A.* 21. *pp.* 207–222, *April*, 1931.—Previous work by Hausser and Vahle, regarding the relationship

of the production of erythema with the exposure when using monochromatic radiation, is reviewed. The colorimetric comparison of the skin erythema with a standard dye, as used by Hausser and Vahle, is criticised, but the results of these investigators may be interpreted by plotting the square root of the dye concentration with the exposure, when a straight line is obtained. In analogy with photometric measurements, where the photographic density varies with the time of development, the production of an erythema is considered to be in similar relationship with the time which has elapsed since exposure. Attention is drawn to the fact that whilst Hausser and Vahle's results were obtained with monochromatic radiation, no experimental work has been carried out with a complex radiation mixture, as used in practice. An additive theorem is assumed, in which, to produce any degree of erythema, the ratios of the intensity at each particular wave-length to the intensity necessary to produce a similar erythema with a monochromatic radiation, must add up to unity. On this assumption the work of Hausser and Vahle is analysed and the effectiveness of various types of lamps considered, particularly the tungsten filament lamp, when enclosed in a quartz bulb, and the mercury-vapour arc. It is stated that one-half of the erythematic effect of the sun is due to energies of wave-lengths longer than 3130 Å., at which region the radiation from a tungsten filament or mercury-arc lamp is relatively ineffective. Transmission of sunlight *via* window glass causes the maximum effective region to transfer to 3350 Å., but the general effectiveness is then only one-twentieth that of the direct non-filtered radiation. Comparison of various lamps and sunlight is made, but it is pointed out that the validity of the results is dependent upon the accuracy of Hausser and Vahle's measurements and the assumption made by the present authors.

B. J. L.

3249. Scheidt Ultra-Violet Ray Tube. E. A. Owen and P. Wright. *Brit. J. of Radiology*, 4. *pp.* 211–217; *Disc.*, 217, *May*, 1931.—A description of a source of ultra-violet light. It consists of a special form of Geissler tube containing inert gases at low pressure and a few globules of mercury. It requires 4000 volts, and will carry 10 mA. The ultra-violet spectrum resembles that of the mercury arc, the strongest band appearing at 254 $\mu\mu$. The emission is much less than that of a mercury arc, but relatively richer in short-wave radiations below 265 $\mu\mu$. The tube may be placed close to, or in contact with, the skin during therapeutic use. W. V. M.

3250. Multix X-Ray Tube. F. D. Owen-King. *Brit. J. of Radiology*, 4. *pp.* 218–231, *May*, 1931.—A description of a self-protected X-ray tube incorporating two filaments enabling the tube to be used for very heavy loads with a broad focus, and also with a very fine focus for radiographic work. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3251. Adsorption and Phase-Boundary Potentials of Resistant Glasses. Part I. F. Seidl. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 1–2. *pp.* 67–77, 1931.—By means of strongly resistant glasses, the dependence of the adsorption potential on the ions of the glass has been investigated. In aqueous NaOH solution, glass 59III exhibits two maxima of the adsorption potential, this observation being explained on the basis of the assumption that the ions of the glass themselves exert electromotive activity and that displacement adsorption takes place. Results are also given of determinations of the phase-boundary potential with these glasses, aqueous solutions of the concentrations used in measuring the adsorption potential being employed. Owing to the paucity of the experimental data yet available, the results are to be discussed in a later publication. T. H. P.

3252. Adsorption of Water by Silica Gel. P. Koets. *K. Akad. Amsterdam, Proc.* 34. 3. *pp.* 420–426, 1931.—The present work was undertaken in view of the differences in wetting properties between a hydrophobic substance, such as carbon, and a hydrophilic one, such as silica gel. The results are given for the adsorption from cane sugar solutions, from solutions of electrolytes and from water-alcohol solutions. It is found that the component with the lower adhesion tension is preferentially adsorbed only at low concentrations, and only then in small amounts. J. K.

3253. Adsorption of Water from Ethyl Alcohol-Water Mixtures by Silica Gel. H. M. Davis and L. E. Swearingen. *J. Phys. Chem.* 35. *pp.* 1308–1313, *May*, 1931.—It is found that water may be preferentially adsorbed from alcohol-water mixtures by silica gel. This occurs when adsorption takes place from the vapour instead of from the liquid phase. The optimum temperature for this preferential adsorption is found to be 78° C. The fraction of the total water present which is removed decreases as the total water content of the mixture decreases. J. K.

3254. Heat of Wetting of Charcoal as a Measure of its Activity. R. Macy. *J. Phys. Chem.* 35. *pp.* 1397–1409, *May*, 1931.—Reference is made to the work of Blüh and Stark, Lowry, Chaney and Allmand. It is confirmed by experimental data that the heat of wetting in benzene is a good rapid test of the value of charcoal as a gas adsorbent. It is shown, however, that the heat of wetting is not a function of the adsorption capacity of charcoal, but of the capacity for firmly holding vapour or retentivity. It is also shown that the heat of wetting in benzene and the retentivity of adsorbed vapour may be considered as a measure of the surface area of charcoal. J. K.

3255. Grain Size of Pulverised Adsorption Substances. F. Krczil. *Kolloid Zeits.* 55. *pp.* 25–30, *April, and pp.* 148–150, *May*, 1931. —The pipette apparatus due to M. Köhn is described. By means of this apparatus the size of grain of carbon and silicic acid containing substances is determined. Whilst active carbons can be distinguished having a small quantity of particles under 0·02 mm., for adsorption substances containing silicic acid or bone black a fairly large percentage of particles can be determined having a size of under 0·001 mm. J. K.

3256. Vapour-Pressure Isotherms and Submicroscopic Structure of Active Charcoals. P. Kubelka. *Kolloid Zeits.* 55. *pp.* 129–143, *May*, 1931.—The taking up of gases and vapours by active charcoals and other capillary substances can be considered from two points of view, namely, (1) specific surface adsorption, and (2) capillary volume and the diameter influencing capillary condensation. Capillary-condensation isotherms at 20° are given for ten different types of charcoal with three to five gases: benzene, ether, chlorpicrin, water vapour and carbon dioxide. Use is made of the Zsigmondy theory and the Thomson equation to calculate the structure curves of the charcoals. It is found that by taking into account the capillarity of the charcoals and the specific gravity and surface tension of the liquefied gases at higher pressures it is possible to give for each gas a definite constant in the Thomson equation. Carbon dioxide behaves well at higher pressures. The theory of Zsigmondy is also well satisfied in this way. J. K.

3257. Influence of Traces of Water on Solution Equilibria in Organic Liquids. S. Miyake. *Kyushu Univ. Coll. Eng., Mem.* 6. 1. [114 *pp.*], 1931. *In English.*—Solubility data are recorded for a number of organic compounds in completely anhydrous solvents, and the influence of water in markedly increasing the solubility has been quantitatively examined. The percentage increase at first rises with increasing dielectric constant and internal pressure of the solvent, passes through a maximum, and then falls. It is probable that the highly polar nature of the water present causes deformation of the dipoles of the solvent and solute, and consequently an increase of the dipole moment; the degree of solvation and therefore the solubility of the solute are thus increased. The same result follows if the degree of association of the solvent molecules is reduced by addition of water, since the forces of attraction between the solvent and solute are lowered; measurements of the molecular weight by the freezing-point method show in several cases that the number of smaller molecules is increased on addition of water. The measurements support Hildebrand's theory of solution. The influence of miscibility of the solvents on the distribution coefficient of certain solutes has been investigated. The increase of solubility of a given solute may be employed to determine traces of water in organic liquids. The solubility of water in benzene between 18° and 38° C. has been determined; the heat of solution is 8·016 k. cal./mol.. H. F. G.

3258. Solubility of Mixtures. W. Haller. *Kolloid Zeits.* 55. *pp.* 6–9, *April*, 1931.—The relationships characterising the solubility of mixtures are deduced from theoretical considerations on equilibrium phenomena. It is thus found that the solubility is dependent on the amount of surface of a body. For heterogeneous phase mixtures as well as for gel mixtures the relationship of the solubility to surface of a body (M) can be represented by ascending curves which are concave to the M-axis. To explain the different curves of various types it is necessary to introduce colloidal-chemical variables. J. K.

3259. Influence of Pressure on the Solubility of Sodium Chloride in Water. L. H. Adams and R. E. Hall. *Washington Acad. Sci., J.* 21. *pp.* 183–194, *May* 4, 1931.—In the method described the conductivity of the saturated solution is measured in a special type of cell containing the solid salt at the top and bottom. Measurements with sodium

chloride at 30° and at pressures up to 4000 bars show that the resistance-concentration gradient, at constant pressure, decreases rapidly with pressure and changes sign at 3000 bars. The results for the change of solubility are in satisfactory agreement with those obtained by other methods.

H. F. G.

3260. Ultramicroscopic Structure of Unimicellar, Iridescent Films of Albumen and other Substances. C. Spierer. *Kolloid Zeits.* 55. *pp.* 36–41, *April,* 1931.—The ultramicroscopic structure of albumen, gelatin, rubber, oil of turpentine, olive oil, and xylene can be rendered visible only by means of a special technique [see Abstract 2073 (1931)], by which extremely thin lamellæ are obtainable. The formation of stratification has been observed only with soap and albumen, all the other substances investigated showing micellar structure. With oils on water, emulsions are formed of a single layer of drops. These results contradict the statement, made by various authors, that the finest oil films arising on the surface of water always or nearly always represent unimolecular layers. This view is based on exact measurements of the quantity of dispersed oil and of the area of the water surface covered by the film, and on the dimensions attributed to the oil molecule. It supposes, therefore, continuity of the oil layer, which is frequently not the case. The fact that the layer of oil may consist of agglomerated droplets renders the basis of such calculations very uncertain. T. H. P.

3261. Orientation in Thin Films of Organic Compounds. J. J. Trillat and A. Nowakowski. *Ann. de Physique,* 15. *pp.* 455–488, *April,* 1931.—The X-ray drop-tangent method [see Abstract 2359 (1929)] is applied to the examination of films of stearic, palmitic, lauric, sebacic, azelaic, suberic, pimelic, and succinic acids, tristearin, tripalmitin, trimyristin, and trilaurin, and two commercial paraffins of melting points 50°–52° and 60°–62°. The films were formed (*a*) by allowing a melted drop to cool, (*b*) by effecting the cooling by a current of air, thereby obtaining films of 0·01–0·001 mm. thickness resting on the same material, liquid, (*c*) on a drop of water at suitable temperature, and (*d*) (fatty acids only) as (*c*), but on a solution of hydrochloric or acetic acid, or of soda. In all cases, save those of the dicarboxylic acids by method (*c*) and to some extent also (*b*), and of fatty acids on a strong solution of hydrochloric acid, definite orientation is found, the reticular distances being in good agreement with the results of other methods. In general the chains are normal to the surface of the film, but those of fatty acids obtained by method (*b*) are inclined. There are indications of polymorphism in the cases of triglycerides by methods (*a*) and (*c*), and of dicarboxylic acids by (*b*). In films of dicarboxylic acids formed by method (*c*) the molecules lie flat with both carboxyls attached to the water. A film of octyl alcohol on a drop-shaped piece of sodium is orientated with the CH_2OH group attached to the sodium. C. A. S.

3262. Swelling of Gels. E. L. Lederer. *Kolloid Zeits.* 55. *pp.* 41–47, *April,* 1931.—The theory of the taking-up and giving-up of liquid (swelling and de-swelling) is presented and tested for the two possible cases, namely: (1) freely mobile liquid molecules, obeying the laws of hydrodynamics; (2) movement of the liquid molecules under a pressure gradient against resistive forces. In particular, the drying of non-swelling substances and the de-swelling of sols are investigated. Immediately before complete

drying, the former show qualitatively the same phenomena as the latter. The course of the drying of sols thus appears to indicate that the liquid is bound in two ways, partly adsorptively at the fields of force, directed outward, of the molecule aggregates, and partly in the interstices. The same is the case with rubber sols, to which micellar structure is to be ascribed. The transition point of the two kinds of drying appears to be that between gel and clot, or between gel and coagel. T. H. P.

3263. Models of Lyophile Colloids. D. Talmud and S. Suchowolskaja. *Kolloid Zeits.* 55. *pp.* 48–64, *April*, 1931.—Experiments with models of lyophile colloids, consisting of three-phase emulsions containing various quantities of surface-active substance (oleic acid), are described. Quantitative measurements were made on swelling pressure, gelatinisation and synaeresis. The following view of the mechanism of the hydration (solvation) of lyophile colloids is advanced. The electric charge of the micelle cannot furnish a cause for the hydration, which is produced by hydration of polar groups contained in the micelle. The degree of hydration of a polar molecule (or of a micelle consisting of polar molecules) in the adsorption layer exhibits a maximum, which is reached prior to the formation of a saturated hydrate layer, and with this maximum there corresponds a maximum mechanical strength of the adsorption layer. With one and the same polar group the strength of such layer increases with the length of the non-polar chain. The structure of a lyophile colloid may be compared with that of two- or three-phase emulsions. The maximum stability of the latter must correspond with the solidification of the adsorption layers separating the disperse phase from the dispersion medium. If, in addition, solidified layers which unite the separate emulsion elements are formed, gelatinisation is realised. Synaeresis is the inverse of gelatinisation and results from the loss by the micelles of the capacity of orienting the water molecules, this occurring if the polar molecules are either wrenched free or changed into hydrophile groups. A consequence of this is the commencement of a disorientation of the hydrate layers, which were previously orientated by polar groups. This disorientation is accompanied by cooling of the system, which retards the synaeresis.
T. H. P.

3264. Passive State of Chromium. Part II. E. Müller and K. Schwabe. *Zeits. f. Elektrochem.* 37. *pp.* 185–197, *April*, 1931.—Continuing previous work on the passive state of chromium [see Abstract 2093 (1931)], it is shown that in the passive state chromium is coated with a layer of chromium oxide fixed into the lattice. The chromium atoms are unable to pass through the meshes of the network of oxide into water solution. When the metal is kathodically polarised, the H ions are drawn into the meshes of the network, and the oxide is dissolved, and the metal becomes active. The oxide network is considered to have wider meshes at the corners and edges, through which acid is able to pass by diffusion alone, and to dissolve the oxide. The metal becomes active at these points, and polarisation of the mass of chromium takes place by short-circuit currents. The limiting potential of activation is shown to be affected by friction and by heat. F. J. B.

3265. Theory of Metallic Corrosion. Part IV. G. D. Bengough, A. R. Lee and F. Wormwell. *Roy. Soc., Proc.* 131. *pp.* 494–517, *May* 1, 1931.—Further experimental results [see Abstract 3278 (1930)] indicate

that the distribution of corrosion on zinc cannot be adequately accounted for by differences in oxygen concentration as postulated by the "differential æration" theory, which states, broadly, that oxygen is needed for corrosion, but that the attack occurs at places relatively inaccessible to oxygen. When placed in a salt solution which does not form a passifying film, either general or local, zinc first displaces hydrogen at a multiplicity of points. No regional distinction can at first be made into anodes and kathodes, which are probably adjacent and constantly changing, as in an acid solution; at any instant the point-anodes are probably sporadically distributed, and corrosion will proceed uniformly except as it is affected by factors related to crystal structure and to the method of preparing the surface, provided that supplies of oxygen and suitable anions are available. The oxygen is needed for depolarisation, and the anions must be such that they form a soluble salt with the metal; corrosion will then proceed at a rate directly proportional to the oxygen supply, as long as the concentration of anions is sufficient and no protective films are formed. An example of this is the initial attack of zinc by ammonium chloride. With zinc, corrosion will not usually be distributed regularly over the whole surface because insoluble substances produced by corrosion may be irregularly distributed and give local protection, and also the supply of oxygen may not be uniform. T. H. P.

3266. Velocity of Corrosion from the Electrochemical Standpoint. U. R. Evans, L. C. Bannister and S. C. Britton. *Roy. Soc., Proc.* 131. *pp.* 355–375, *May* 1, 1931.—Experiments were made on the relationship between the velocities of corrosion and the current flowing between the kathodic and anodic areas. It was shown that the currents measured were equivalent to the corrosion produced. This relationship held for kathode and anode of the same or different metals. The problem of corrosion velocity was therefore resolved into a study of electrochemical factors which determined the strength of this current. Polarisation caused the kathodic and anodic potentials to approach one another, and in most cases the polarisation which limited the corrosion rate occurred at the kathodic area, and was due to limitations in the rate of oxygen supply. F. J. B.

3267. Stainless Metals. H. Carpenter. *Roy. Soc. Arts, J.* 79. *pp.* 558–584; *Disc.*, 584–592, *May* 8, 1931.—The paper is a review of the stainless metals, especially stainless irons and steels, from the point of view of corrosion. The various theories of the protective film and the part it plays in the reduction and prevention of corrosion are discussed. The different types of stainless steel, including low-carbon and cutlery grades, and other high-chromium steels are described, and their properties and uses are discussed. The paper does not lend itself to abstracting, and the original should be consulted. F. J. B.

3268. X-Ray Investigation of Lead-Bismuth and Tin-Bismuth Alloys. D. Solomon and W. M. Jones. *Phil. Mag.* 11. *pp.* 1090–1103, *May*, 1931.—This work continues a previous investigation on crystal structures in binary systems [see Abstract 1712 (1931)]. It is found that the crystal structures of the Pb-Bi and Sn-Bi systems are different from those of the Pb-Sb and Sn-Sb systems, although the crystal structures of Sb and Bi are alike. Whereas Pb easily takes Bi into solid solution, Sb is practically insoluble in Pb. Pb, however, is practically insoluble in

Bi and Sb. From work on the Sn-Sb system, Sn and Sb form a compound SnSb having a sodium chloride structure, and regions of solid solution exist both at the Sn end and the Sb end of the equilibrium diagram. Alloys of Sn and Bi, on the other hand, are just mixtures of the crystalline phases of the component elements. H. H. Ho.

3269. Limits of Inflammability of Gases and Vapours. H. F. Coward and G. W. Jones. *Bureau of Mines, Bull.* 279. [114 pp.], 1931. —The paper is a critical review of all figures published, and some hitherto unpublished, on the limits of inflammability of combustible gases and vapours in air, oxygen and other " atmospheres." The results are of fundamental importance in the study of explosions in mines, and in the prevention of gas explosions and fires in the metallurgical, petroleum, gas-manufacturing and related industries. The limits (upper and lower) of inflammability are the two border-line compositions where a slight change in one direction produces an inflammable mixture; in the other a non-inflammable mixture. For example, for methane-air mixtures, these limits are under normal conditions approximately 5 and 14 % methane respectively. The effects of the particular source of ignition used, the direction of flame propagation, the diameter, length and nature of the containing vessel, small changes in atmospheric condition, pressure, temperature and turbulence are carefully considered. A method is given of calculating limits of inflammability of complex industrial gases, containing mixtures of H_2, CO, CH_4, N_2, CO_2 and O_2. Numerous curves and tables are included in the paper, together with a comprehensive Bibliography. T. B.

3270. Kinetic Theory of the Induction-Period of Chemical Reactions. P. Das. *Indian Phys. Math. J.* 2. *pp.* 11–14, *March*, 1931. —The name induction-period appears to suggest that during this interval of non-appearance of the precipitate no chemical action takes place, but the reacting substances prepare themselves for the reaction, as it were. It is shown in the present paper that no such assumption is necessary, that the phenomena can be semi-quantitatively explained on the basis of the kinetic theory, and that the molecules of the compound formed take time to coalesce with one another and grow into a grain of size large enough to produce general opacity of the medium or any colour-effect. It is the period of growth of these particles that appears to be an induction-period. H. H. Ho.

3271. Methods of Calculating and Averaging Rate Constants. W. E. Roseveare. *Am. Chem. Soc., J.* 53. *pp.* 1651–1661, *May*, 1931.— The rate constants of both uni- and bi-molecular reactions may be calculated analytically when the initial concentration or time cannot be determined, but this procedure is not to be recommended when it is possible to determine the initial concentration accurately by direct means, as it has greater probable error. The simple arithmetic average of rate constants, commonly used, is incorrect, and should never be used except for averaging rate constants calculated from entirely independent data, and then only when the probable errors are nearly alike. The method of least squares should be used with caution, but the graphic method may be employed in all cases where each point on the graph represents an entirely independent result. If it is found that the rate law holds within the limits of experimental error, more values of k should be obtained from independent data for approximately the optimum concentration change.

Such values of k may then be averaged either graphically or arithmetically. T. H. P.

3272. Dipping Electrodes for Electrodialysis. J. Lindner and N. Figala. *Kolloid Zeits.* 55. *pp.* 3–6, *April*, 1931.—Dipping electrodes and their arrangement in use are described with the aid of illustrations. The various new applications of such electrodes are also given. It is pointed out that these electrodes have further applications than merely for the purification of organic substances in biological investigations. They can, for instance, be used for the general purification of organic substances of high molecular weight. J. K.

3273. New Cell for Electrodialysis. H. N. Holmes and A. L. Elder. *J. Phys. Chem.* 35. *pp.* 1351–1354, *May*, 1931.—A new apparatus is described, constructed according to a suggestion of Kruyt that the electrode compartments should be as small as possible. With 0·01*N* NaCl no test for chloride ions can be obtained after ten hours of dialysis at 155 volts and 65°–70°. This apparatus has been used to remove salts from gelatin. J. K.

3274. Improved Null Instrument for Glass Electrode or other High Resistance Circuits. S. E. Hill. *Science*, 73. *pp.* 529–530, *May* 15, 1931.—With most of the valve amplifiers for use with glass electrodes either the grid current of the valve is large enough to cause polarisation of the glass membrane or other difficulties arise. With the new valve described by Metcalf and Thompson [see Abstract 577B (1931)] the grid current is, however, so small (10^{-15} ampere) that it introduces only negligible errors in the measurement of potentials of systems of very high resistance. Thus, glass electrodes with resistance as high as 100,000 megohms may be used without difficulty in the grid circuit of the tube. The measured potential of a standard cell in series with this valve is the same as when obtained directly. The use of this valve renders possible the use of thick glass membranes of small area, simplifying the drop method of MacInnes and Dole [see Abstract 2373 (1930)] by permitting the use of thicker and more rugged glass membranes. A diagram and details of the circuit are given. T. H. P.

3275. Measurement of Glass Electrode Potentials. G. D. Greville and N. F. Maclagen. *Faraday Soc., Trans.* 27. *pp.* 210–222, *May*, 1931.—Details are given of the construction and operation of a simple thermionic valve electrometer capable of potential measurements through a resistance of 10^9 ohms with an error of $\pm$ 0·05 mV (pH $\pm$ 0·001). Methods of testing for grid current, electrical leakage, faults in the glass electrode, and other sources of error are described. The MacInnes and Dole type of electrode, 2–3 mm. in diameter, is the most satisfactory, but it should not be left dry after use for any considerable period, or an asymmetrical potential may develop; an improved method of mounting, whereby breakages are considerably reduced, is described. In feebly buffered viscous solutions the glass electrode attains the characteristic value very slowly, but this sluggishness may be reduced by using a rotating vessel for the solution. H. F. G.

3276. Potential of the Graphite Electrode. B. v. Lengyel. *Zeits. f. phys. Chem.* 154. *Abt. A.* 5–6. *pp.* 371–378, *May*, 1931.—The potential of the graphite electrode was measured in solutions of HCl of

different concentrations, and in a number of solutions of salts of mono-, di-, and trivalent metals. The potential is found to be definite to $\pm$ 0·01 volt, and is mainly dependent on the pH value of the solution, but is nearly independent of the air or hydrogen charge of the electrode. The results of the investigation show that the potential of graphite is determined by the adsorption of ions. F. J. B.

3277. Gas Electrodes. A. C. Krueger and L. Kahlenberg. *Am. Electrochem. Soc., Trans.* 58. *pp.* 107–149; *Disc.*, 150–152, 1930.—The effects of oxygen, hydrogen, nitrogen, helium and argon upon the potentials of all the common metals and carbon were studied in KCl, KOH and HCl solutions. The potentials of arsenic, natural graphite, cocoanut charcoal, cadmium, mercury, molybdenum, lead, silicon, tin, tantalum, tellurium, tungsten and zinc were only slightly affected by the gases in all three electrolytes. The experimental data obtained showed that the so-called gas electrodes were really gas-metal electrodes. The potential effects observed had no connection with the valency or with the position of the element in the periodic system. Argon and helium produced as characteristic effects on the potentials as hydrogen, oxygen, or nitrogen. F. J. B.

3278. Reductivity of Hydrogen at Metal Surfaces in Relation to Overpotential. G. R. Hood and F. C. Krauskopf. *J. Phys. Chem.* 35. *pp.* 786–795, *March*, 1931.—An apparatus and method for the direct measurement of kathode potentials during electrolytic reduction, whereby contamination of the electrolyte is avoided, have been developed with the object of investigating the relationship between overpotential and efficiency of reduction. Measurements with kathodes of various metals in 0·1 *N* sulphuric acid solution demonstrate the great influence of the nature of the metallic surface and the variation of the overpotential with time as a result of surface changes. For random experiments the relation between the overpotential π and the polarising current density I approximates to the type $\pi = a + b\mathrm{I}$, where a and b are constants, but systematic measurements with increasing current and longer time intervals conform more nearly to the theoretical equation. The efficiency of the reduction of potassium chlorate solutions falls with increase of kathode potential, becoming negligible at about 1·5 volts. The mechanism of the process is discussed in the light of the electrolytic experiments, together with others on the catalytic reduction by hydrogen in presence of platinum black and on the decomposition potential. On the hypothesis that evolution of gas results from a collision of hydrogen with hydrogen, and reduction from a collision between hydrogen and chlorate ions, it appears that only slowly moving atoms can bring about reduction; it is suggested that the resonance principle is applicable to such processes. H. F. G.

3279. Transport Numbers and Transport Potentials in Metallic Solutions. K. Schwarz. *Zeits. f. phys. Chem.* 154. *Abt. A.* 3–4. *pp.* 245–254, *April*, 1931.—The existence of electrolytic phenomena in metallic solutions requires the production of polarisation voltages. Relationships are developed from thermodynamical reasoning between e.m.f., concentration, transport numbers and molecular conductivity. The theory was tested by measurements on the transport numbers and transport potential of cadmium amalgams. The dependence of transport numbers on concentration and the e.m.f. was confirmed by the experimental results within the limits of experimental error. F. J. B.

3280. Transference Numbers of Potassium Chloride. D. A. MacInnes and M. Dole. *Am. Chem. Soc., J.* 53. *pp.* 1357–1364, *April*, 1931.—Results are given of a series of measurements, by the Hittorf method, of the transference numbers of KCl at 25° and for the concentration range 0·02–3·0 *N*. The kation transference numbers found are appreciably lower than the generally accepted values, on which the tables of ionic mobilities are based. The new values are, however, in excellent agreement with a series of values for the same constants obtained by the moving-boundary method; the details of the latter determinations are to be published later. Within the limits of experimental error, the transference numbers are constant between the concentrations 0·01 and 0·1 *N*, and the kation number decreases slowly as the concentration is raised above the latter value. T. H. P.

3281. Conductance of Electrolytes. Part IV. Validity of Ohm's Law for Electrolytes. G. Jones and G. M. Bollinger. *Am. Chem. Soc., J.* 53. *pp.* 1207–1212, *April*, 1931.—Wien has shown experimentally [see Abstracts 2754 and 2765 (1927)] that deviations from Ohm's law amounting to more than 50 % in some cases occur in electrolytes at very high field strengths (3000–300,000 volts per cm.). It is now found that, if adequate precautions are taken to avoid errors due to heating, polarisation and the secondary effects of inductance and capacitance, there is no measurable variation in the real resistance of electrolytes with variation of the applied voltage throughout the whole range of voltages and frequencies suitable for use in the Kohlrausch method of measuring electrolytic conductance. Ohm's law may, therefore, be regarded as valid for electrolytes under such conditions. [See also Abstract 2512 (1931).] T. H. P.

3282. Dispersion of Conductivity of Electrolytes. B. Brendel. *Phys. Zeits.* 32. *pp.* 327–336, *April* 15, 1931.—A resonance method for comparison of the conductivities of electrolytes in a h.f. field is described. Results of determinations at wave-lengths of 16 and 30 m., with electrolytes of various types, are reproduced as a function of the concentration. The occurrence of a decrease of conductivity, such as that reported by Deubner for hydrochloric acid solutions at a wave-length of 34 m., has not been observed. In general the experimental conductivity-concentration curves agree well with those derived theoretically. The measurements with acetic acid suggest that weak electrolytes do not exhibit anomalous behaviour. H. F. G.

3283. Application of the Barretter Method to Electrolytic Measurements. O. Neese. *Ann. d. Physik*, 8. 8. *pp.* 929–955, *April* 10, 1931.—A barretter method is described which allows the resistance and capacity variations of a conductor for high frequencies to be measured at the same time. The sources of error are fully discussed. As applications of the method results are given of measurements at a frequency $4{\cdot}35 \times 10^7$ on common salt, magnesium sulphate and barium ferrocyanide in aqueous solutions, and on magnesium sulphate and barium ferricyanide in 50 % sugar solutions. The conductivity of all the solutions was $3{\cdot}6 \times 10^{-4}$ ohm^{-1} cm.$^{-1}$. The results of the measurements of the conductivity and of the dielectric constant in the aqueous solutions corresponded approximately to the values to be expected from the Debye-Falkenhagen theory. The probable error of the conductivity measurements is of the order of 0·5 %, and of the capacity measurements 0·3 %. [See also Abstract 621 (1931).] A. W.

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